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OF CEYLON.

Edited by

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THE TEA RESEARCH INSTITUTE
St. Coombs, Talawakelle.

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The Tea Research Institute of Ceylon.

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NOTE

The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address:—Research, Talawakelle, Telephone, Talawakelle 44 (Private Exchange) It is particularly requested that letters should not be addressed to officers by name.

PROCEEDINGS OF THE FIRST SYMPOSIUM ON BLISTER BLIGHT CONTROL.

The First Symposium on Blister Blight Control was held at the Grand Hotel, Nuwara Eliya, on the 10th November, 1949. A Symposium is, in the modern sense of the word, "a set of contributions on one subject from various authors." The authors contributing to the Symposium reported in the following pages represented all the principal tea producing countries of the world and the more grandiose title of the "First International Symposium, etc.," could have been used with some justification.

The visitors from abroad, who came to Ceylon specially to study Blister Blight, are listed below.

Mr. S. Ananda Rau	...	Scientific Officer, United Planters' Association of South India.
Mr. P. de Jong	...	Scientific Officer, United Planters' Association of South India.
Dr. H. Dike	...	Metallo-Chemical Refining Co., London.
Dr. R. M. Greenslade	...	Pest Control Ltd., Cambridge.
Mr. C. J. Harrison	...	Director of the Indian Tea Association's Research Station at Tocklai, Assam.
Mr. F. W. J. Lane	...	Plant Protection Ltd., London.
Mr. W. Wilson Mayne	...	Scientific Officer, Kanan Devan Estates (Messrs. James Finlay & Co., S. India).
Dr. J. Reitsma	...	Head of the Phytopathological Division of the Institute for Plant Diseases and Pests of the Central Agricultural Research Station, Buitenzorg, Java.
Ir. J. H Van Emden	..	Botanist, West Java Experiment Station, Buitenzorg, Java.

Every effort was made to give the proceedings a practical bias without restricting their inevitably technical nature. Such a conference was also liable to become preoccupied with spraying and dusting so precautions were taken to prevent the agricultural aspects of control being overshadowed.

The meeting therefore commenced with a technical survey of the whole Blister Blight problem from Assam to Sumatra. This was followed by Agency House and Planting views of the situation in Ceylon.

With the total available information before them, Mr. Lane and Dr. Greenslade then gave their impressions. These two

gentlemen, both with wide experience of large scale crop protection measures, had come to Ceylon to give their advice. At this stage of their visit nothing more than impressions could be asked of them and this point should be stressed.

The more technical contributions were again balanced by an open discussion in which representatives from the Planters' Association, including the Agency Section, were invited to take part. Most District Planters' Associations were represented and apart from the speakers on the platform some 80 others were present in the conference room.

It was also most fortunate that the Ceylon Association in London could be represented by Mr. Hugh Campbell and Mr. Norman S. Pryor who were on a visit to Ceylon at the time.

Regrets were expressed at the meeting that the Hon'ble the Minister for Agriculture and Lands could not attend the Symposium but Dr. J. W. L. Peiris, the Plant Pathologist of the Department of Agriculture, was specially welcomed.

A Symposium organised on such a broad basis raises the difficulty about esoteric terms which convey special meaning to the technologist but which are apt to bewilder the uninitiated. A glossary of scientific terms used in the text of the papers was therefore made available to those requiring such and is appended to the programme which is now given for the sake of completeness.

10-00 a.m.

1. Formal opening by Dr. Roland V. Norris.
2. Technical Reports on the Blister Blight situation.

(a) *Ceylon.*
- (i) General Position — Mr. J. Lamb
- (ii) The Work in Progress — Mr. C. A. Loos.
- (iii) Agricultural Aspects — Mr. G. B. Portsmouth.

(b) *South India.*
- (i) Mr. Ananda Rau.
- (ii) Mr. W. Wilson Mayne.

(c) *North India.*
Mr. C. J. Harrison.

(d) *Sumatra.*
Ir. J. H. Van Emden & Dr. J. Reitsma (Read by Ir. J. H. Van Emden).

3. Agency House views on Blister Blight situation — Mr. G. K. Newton. (Read by Mr. L. E. Baker).
4. Planting views on Blister Blight situation — Mr. Kenneth Morford.

12-30 p.m.—(Approximately).

BREAK FOR LUNCH.

2-00 p.m.

5. Provision for Mr. Lane of Plant Protection, Ltd., and Dr. Greenslade of Pest Control, Ltd., to express their views.
6. Open discussion. (Each speaker limited to a maximum of five minutes).
7. Summing up by the Chairman of the Board of the Tea Research Institute — Mr. R. C. Scott, C.B.E.

BREAK FOR TEA.

8. An exhibition of sound films kindly provided by Messrs. Plant Protection Ltd. and Messrs. Pest Control Ltd.
   - (i) The Wines and Vines of France (Colour film by Plant Protection Ltd.).
   - (ii) The Gentle Menace (Pest Control Ltd.).
   - (iii) The International Colorado Beetle Campaign. (Colour film by Plant Protection Ltd.).
   - (iv) The Hidden Enemy (Pest Control Ltd.).

GLOSSARY OF SCIENTIFIC TERMS USED IN TEXT OF PAPERS TO BE READ AT SYMPOSIUM.

Basidiomycete.—Comprises a wide group of fungi such as mushrooms, toad stools, Poria, etc.

Clone.—All those plants produced by vegetative propagation from a single mother bush.

Haustoria.—A special hyphal branch, within a living cell of a host, for absorption of food.

Hyphae.—Fungus threads.

Leaf Cuticle.—The outer skin of a leaf.

Mycelium.—A mass of hyphae forming the body of the fungus.

Obligate Parasite.—Living solely as a parasite and entirely dependent on the living host to complete its life cycle.

Organic Fungicide.—An organic fungicide may be somewhat loosely described as one in which the active ingredient is a complex compound of carbon and other non-metallic elements such as oxygen, hydrogen, nitrogen and sulphur. It contains no metallic element.

Phloem.—A specialised tissue in the stem and roots of plants for the transport of elaborated food.

Spore.—The seed, or reproductive structure, in fungi.

Systemic.—(Lit.). Of the bodily system as a whole — not confined to a particular part.

(Tech.)—A fungicide or insecticide which is absorbed by some part of a plant and generally distributed to render the whole plant toxic to the particular pest.

Plant Chemotherapy.—Plant treatments parallel to the use of Penicillin and "Sulpha" drugs in medical treatment.

FORMAL OPENING ADDRESS

BY

ROLAND V. NORRIS,

Director of the Institute.

I propose to occupy your attention for but a few moments as I wish to leave as much time as possible for the more technical discussion which is to follow. But I think it is desirable that I should briefly explain what is the background of this meeting and the purpose it is hoped it will serve.

When Blister Blight first appeared in Ceylon in 1946 there was widespread dismay in many quarters and fears that the tea industry might be about to suffer the fate which befell coffee, sixty or seventy years ago. Fortunately, the technical knowledge already at the disposal of the Institute enabled us to assure the Industry that any such disaster was in the highest degree unlikely though we were then naturally unable to make any assessment of the loss of crop and other damage which might be caused by the disease. We informed you frankly that in our opinion the possibility of *eradicating* the disease was a remote one but we were able almost immediately to suggest to you certain *palliative* measures mostly of a cultural nature.

Since that period opinions about the danger of the disease have tended to fluctuate. 1947 was a year favourable to crop with a light monsoon which did not unduly encourage Blister Blight. Damage, in consequence, was in general appreciably less than had been anticipated and a considerable degree of optimism arose. So much was this the case in fact that the Institute felt it necessary to issue a definite warning that the disease was in no sense to be taken lightly. This warning has been justified by subsequent events. Blister Blight attacks were more severe in 1948 and have been much more prominent, at any rate in the South West zone, during the present year which has been marked by a long wet season and more than usually sunless weather.

By this time the general condition of some of our tea, particularly up-country, was causing anxiety. In actual fact a number of causes have been responsible for this, but Blister Blight has been a convenient label to cover all the ills to which tea is subject and the position has become somewhat distorted in consequence.

As a result, in certain quarters, and possibly contributed to by a lack of knowledge and appreciation of the work already carried out by the Institute, there arose an impression that enough was not being done to control the disease and a demand developed that expert assistance at the highest level should be obtained from abroad.

The whole question was discussed in Colombo when I hope the position was to a large extent clarified. Briefly, the position is as follows : Work on the laboratory side to investigate the nature and life his-

tory of the fungus responsible and the methods by which it establishes itself in the bush was first necessary before effective measures of field control, other than the cultural modifications already referred to, could be devised. That work was vigorously taken in hand by the Institute and may be considered as the first stage in our programme. You will hear further of this this morning, but I feel I can say with full confidence that stage one has been successfully completed and that field work will not be held up or handicapped by any lack of theoretical knowledge on our part.

The next problem, or Stage II, concerns the investigation of improved protective measures in the field. In Ceylon, owing to the nature of the terrain, local climatic conditions and similar factors such work presents particular difficulties and it was here that the Institute felt that expert advice could be most helpful. Arrangements were accordingly made to obtain the services on a temporary basis of experts connected with Messrs. Plant Protection Ltd., and Pest Control, Ltd. As regards these arrangements, I should like to acknowledge the help I have received from Mr. G. K. Newton, and my Deputy Director, Mr. Lamb, who, during a very brief visit to the United Kingdom contacted everyone in a position to assist us and thereby saved a great deal of time in securing the help we required.

As a result, we have with us here today Mr. Lane of Plant Protection Ltd., and Dr. Greenslade of Pest Control Ltd. and on your behalf I extend to them a very cordial welcome. I should be most unfair to these two gentlemen if I allowed you to think that in the reports we hope to receive from them in a few weeks' time, you will find a cut and dried solution to Blister Blight. They are here to study our conditions and to obtain from yourselves and others the fullest possible knowledge of our difficulties. Combined with that they are themselves carrying out tests of improved spraying technique. Their work, in fact, may be considered as a general reconnaissance as a result of which we hope they may be able to suggest further lines of investigation on a very considerable scale which will later form Stage III of our programme.

We felt we should take advantage of the presence of these two officers to collate all the facts possible about Blister Blight, and we accordingly extended invitations to technical representatives from North-East and South India and Indonesia to be present here today. I am glad to say that all these invitations were cordially accepted and, as you will see from the programme before you, you will shortly have the opportunity of hearing these officers express their views on the problem before us.

At the same time we felt that the Agency and the purely planting view should be presented and this will be done in papers kindly prepared by Mr. G. K. Newton and Mr. K. Morford.

By this stage of the proceedings we anticipate that Mr. Lane and Dr. Greenslade may be suffering from a certain degree of mental indigestion. We propose, therefore, then to adjourn for lunch after which these two officers will address you.

Following their talks the meeting will be open for general discussion. In this discussion, amongst others, we hope representatives from different planting districts will briefly refer to any facts which they may consider to be of particular importance under their local conditions. Here I must introduce an urgent plea for brevity as it will be necessary to restrict such speeches to five minutes and Mr. Lamb will operate with some vigour the red and green lights which have been installed to warn you if your allotted span is being exceeded.

In this connection, as we have many visitors with us to whom many of you may be unknown, it will be of assistance if each speaker will, on rising, give his name and designation.

Before concluding, I must refer to the financial implication of the programme of work which may have to be undertaken. It is likely that very considerable funds may be required which cannot be met from the existing resources of the Institute. In these circumstances the Hon'ble the Minister of Agriculture and Lands has been approached and we have reason to hope that a substantial sum will be released from the balances standing to the credit of the Tea Control Fund.

I will now call on Mr. Lamb, the Deputy Director of the Institute, to speak.

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2. TECHNICAL REPORTS ON THE BLISTER BLIGHT SITUATION

Ceylon I. The General Position.

J. LAMB.

During August when I flew to the U.K. and was able, amongst other things, to make arrangements for Dr. Greenslade's and Mr. Lane's visit, I had to see Professor Sir Frank Engledow, Professor of Agriculture at Cambridge. As most of you probably know, Sir Frank Engledow has been in close touch with the problems of the Tea Industry for a number of years and he made the suggestion that while Mr. Lane and Dr. Greenslade were in Ceylon it would be a good idea to have a Conference of Scientific Officers from all countries afflicted with Blister Blight. That suggestion bears fruit today.

Now although this conference is primarily a scientific one, we have asked Planters and Agency House Representatives to attend. We therefore decided to call it a symposium — not, I hasten to say, because a symposium is defined in the Dictionary as a drinking party, but because by the modern usage of the word it means a set of contributions upon one subject.

My function is to set the ball rolling or perhaps I should say, to avoid mixing metaphors, to draw the first cork. The way I propose to do this is to give a simple summing up of the whole problem. The various speakers following will deal with the specialised aspects and so I will try to draw a simple picture of the wood and leave them to fill in the trees.

Dr. Norris has referred to the essential stages of the fight against disease and it is important that our general plan of campaign should be borne in mind.

The first stage must be a complete investigation of the exact nature and course of the disease for without this basic knowledge little can be achieved. The patient and systematic work of Dr. Gadd and Mr. Loos has completed the first stage. Mr. Harrison, Mr. Ananda Rau, Mr. Van Emden and Dr. Reitsma will, I think, support the general conclusions of this work. If they have anything to add, or to contradict it

will make an extremely interesting contribution to the symposium. I will recapitulate the conclusions drawn from this work in the simplest of possible terms.

(1) The disease is not a virus disease and so there is real hope of immediate progress.

(2) The disease does not attack mature leaf, and so there is little fear of a repetition of the coffee crash.

(3) The disease is a fungus which is transmitted by spores. These spores are destroyed by a few minutes exposure to direct sunlight but can live for a week in an atmosphere of 90 per cent relative humidity. Hence the importance of sunny periods, shade, and mist.

(4) The spores alight mainly on the upper surface of leaves. Mr. Loos will explain how this simplifies spraying problems

(5) Under special conditions of humidity and free moisture, such as dew, the spores germinate in 6 to 24 hours. The spores have a special method of anchoring themselves to leaves so that they can force entry to the leaf tissue.

IT IS IMPORTANT TO MAKE IT QUITE CLEAR THAT THE DISEASE IS AMENABLE TO TREATMENT UP TO THE STAGE OF GERMINATION.

(6) The disease is only able to force its way into leaf up to 30 days old. Occasionally it does get into old leaf but this is comparatively rare.

(7) After entry of the germ tube into the leaf the fungus grows rapidly and semi-transparent or translucent spots appear in 6 to 10 days. The fungus matures and seeds in 18 to 21 days. The Blister may therefore appear on leaves which are 30 plus 18 days old and give the false impression of attacking older leaves. The spores when ripened are ejected with considerable force and are wind borne.

ONCE THE FUNGUS HAS GOT INTO THE LEAF IT IS PRACTICALLY IMPOSSIBLE TO CONTROL THE COURSE OF THE DISEASE. TREATMENT MUST THEREFORE BE PREVENTATIVE.

(8) Mr. Loos will tell you that there is no resting stage of the spore which enables it to survive for long periods under adverse conditions.

(9) There is no alternative host which will harbour the disease and nullify control measures.

Now, I pass on to the second stage which is essentially a reconnaissance of all possible protective measures based on the knowledge gained in Stage I. This symposium may be described as the climax of Stage II. Mr. Loos will tell you that he has been busy with these considerations for some time.

Mr. Lane and Dr. Greenslade have been invited to help us because they have wide experience of large scale control measures against pests and diseases and can save us much unfruitful effort. Very briefly, I will outline the problems arising with control measures.

1. Sunshine is our greatest ally. We cannot regulate it unfortunately, but we can take advantage of it by the judicious control of shade. Mr. Portsmouth will enlarge on this.

2. Drought is another controlling factor which we cannot influence. We know from our experience early this year that a long period

of Island-wide drought sets the disease back a long way and that it takes a very considerable time to build up again after a long dry period. Since there is no resting stage of the spore and no alternative host, the disease has to carry over on young growth inside bushes and in damp shady situations. Could we set the disease back still further and delay its build-up far into the monsoon by a dry weather spraying campaign ? Small holdings and abandoned areas would require special consideration.

3. A measure which Dr. Gadd and Dr. Tubbs were quick to recognise was the alteration of pruning season so that the peak of susceptibility occurs in dry sunny weather. There is grave danger of the soundness of the advice being forgotten.

4. Since there is a long period between infection and actual damage to flush, hard plucking on short rounds as recommended by Dr Gadd affords some measure of control. As Mr. Portsmouth will tell you such treatment must be followed by a short rest. The main difficulty with this approach appears to be the control of labour.

5. Mr. Portsmouth will also raise the question of selection for resistance. Mr. Portsmouth's main task will be to counterbalance the weightage on spraying which is most probable in later proceedings. Purely agricultural methods of control must receive their due measure of consideration.

6. As Mr. Loos will tell you, the protection of Tea recovering from pruning is a possibility. Let me emphasise that we must have our methods worked out before we embark on adventure in this realm of possibilities. Problems arising from altered crop and labour distribution when pruning is concentrated into a short period preceding the dry weather season, tend to make this approach one of prime importance.

7. Again it is possible to protect tea in bearing with copper fungicides. As it is my own territory, I will give you a little more detail about the spray residue problem.

Tea has a natural copper content averaging about 25 to 30 parts per million. Occasionally one finds a content of up to 60 parts per million. The food and drug authorities of most countries seem to tolerate up to 60 parts per million of copper in foodstuffs. Copper is an essential element in human nutrition, but like all good things one can have too much of it. If our teas contain more than 60 parts per million we are likely to find ourselves in conflict with food and drug regulations.

We are therefore searching for fungicides which do not leave objectionable residues. Mr. Loos will tell you more about this type of fungicide which we call an organic fungicide. It is self evident that such fungicides must not cause taints apart from residues detectable by an Analyst.

Decisions on possible control measures are one thing. The economics of control is another stage which has yet to come. Before Mr. Lane and Dr. Greenslade leave Ceylon we hope to be able to decide on the most promising methods and plan the third stage of our campaign to test the economics of control on a large scale.

I sincerely hope that success will be achieved.

Ceylon II. The Work in Progress

C. A. LOOS.

Three years ago, almost to a day, we received a consignment of diseased specimens which had been delivered through the post. One look was sufficient to identify the dough-like formations on the leaves as Blister Blight of which we had heard so much but which we had not previously seen in Ceylon. An area of 3 to 4 acres, pruned 4 months previously, was reported heavily infected. The blisters had done their damage and millions of spores had already been liberated. As Mycologists we knew that a new and unpredictable problem was with us and that Blister Blight had come to stay.

The advent of Blister Blight opened out a wide field for research. That work has gone patiently forward with all the means at our disposal and we have now accumulated a large amount of data which can be of great value both in control and in the planning of future experimental programmes.

A mature *Exobasidium vexans* spore, as is common with many other species of *Basidiomycetes,* is ejected from the basidium with a fair degree of force. The outer covering of the spore is a sheath of mucilage, which cements it firmly to any object with which it may make contact. Being an obligate parasite the fungus can only complete its life cycle, if the spore alights on susceptible material such as a young tea leaf or stem. Our efforts to grow the fungus under cultural conditions, on synthetic media, have been unsuccessful, nor is there evidence of the formation of a resting stage, common to so many other fungi.

For nearly 50 years it had been assumed that the hyphae of germinating *Exobasidium vexans* spores made their entry, into the tea leaf, through the breathing pores (stomata) on the undersurface of the leaves. Our researches have proved that there is no such stomatal attraction and that entry is mainly by mechanical penetration through the leaf cuticle. This knowledge has had far reaching effects in reducing spraying costs, as it becomes unnecessary to pay special attention to the undersurface of leaves.

In the leaves, the main hyphal strands or mycelium, which make up the body of the fungus, are intercellular, while food to nourish the colony is absorbed from the cells through lobed-shaped haustoria. In young stems these absorbing organs are mainly formed in the phloem tissues where the eloborated plant foods are found.

Spores alighting on the leaves of Eucalyptus, Gordonia, Camillia and many other species of plants germinate readily, but are unable to enter the leaf. The problem therefore arises as to what causes resistance in some tea bushes. Is it consequent on the failure of the germinated spore to force an entry through the cuticle or is it due to some toxic agent set up in the leaf tissues following the stimulus of a mechanical breakdown. The answer to this question is being actively pursued.

In 1947, Dr. Tubbs's Experiments demonstrated the efficiency of copper fungicides in the control of the fungus. For tea recovering from pruning it is doubtful whether more efficient and cheaper fungicides than those of the copper group will be found, but in the case of tea in plucking, copper spray residues above a certain limit, may get us into difficulties with Food and Drug authorities. So, for this reason, the

Tea Research Institute is unable to advise the indiscriminate spraying of large areas of tea.

Mr. Lamb's analyses of the copper in sprayed tea showed that it may rise to 370 parts in a million if spraying is followed by a dry period. Adequate control of Blister may be obtained, however, by spraying fortnightly at the rate of 8-10 gallons per acre, using Perenox as a suspension of 4 oz. in 10 gallons of water, while the copper residue on the leaf may be still further reduced if spraying follows immediately after plucking and rain intervenes between the spraying and the next pluck. The copper figure in such cases may be as low as 60 parts per million.

In a search for a fungicide which would not affect the manufactured product, our attention was drawn to more modern developments in fungicidal protection with the so-called organic fungicides. Contact was established with some of the larger manufacturers in the United Kingdom and the United States, who, I am pleased to say, sent us samples of their preparations at considerable expense to themselves. We have thus been able in recent months to try out the following main groups of organic fungicides —

Salicylanilide,
Tetramethylthiuram disulphide (T. M. T. D.),
Four different Dithiocarbonates,
Botrilex (a chloronitrobenzene preparation),
Dinitrocapryl Phenyl crotonate,
Calcium thioglycollate, and
Vitospor — a dust containing copper 8-quinolinolate.

T.M.T.D. showed a fair degree of control when used at 15¼ lbs. per acre.

With the exception of vitospor the other organics under trial proved ineffective as control agents. Vitospor is a dust which incorporates, in addition to copper quinolinolate, about 10 per cent of copper oxychloride.

Dusts usually require fairly heavy rates of application. In the case of Vitospor about 18 lbs. per acre is used, which is equivalent to 1.8 lbs. of copper oxychloride. We already know that ¾ lb. of Perenox per acre will give effective control, so that in this case it is possible that the copper oxychloride is the controlling agent. There is, however, some possibility that dusts may be easier to apply and further investigation with the material will be necessary. Tests with other quinolinolate compounds are also included in these plans.

Our interest in the field of organic fungicides has resulted in the offer of trial samples from a number of manufacturers. This work will be given a high degree of priority and we very much hope that a fungicide, highly toxic to *Exobasidium* will eventually be found.

In regard to tea recovering from pruning, we know that one third to one fourth of the tea in Blister Blight areas is pruned each year. In the South West Monsoon areas pruning is inadvisable before early December while in areas subject to the North East rains we have advised pruning in April. This results in pruning operations being concentrated into a very short period, greatly increasing the difficulties of management. A further drawback is the longer period necessary for recovery. This may result in a loss of crop which is estimated at 25 to 30 lbs. made tea per acre in the first five months of the first year. We know, however, that it is possible to prune in June or July and get efficient recovery if the bushes are protected from bud-break to tipping with a copper fungicide. But the cost of such an operation has to be sufficiently low to benefit by the extra crop brought in. In very early experiments

conducted by Dr. Tubbs, Perenox was sprayed at the rate of 50-70 gallons per acre. Figures collected from estates which pruned in September and October last year show that with the old type of Knapsack Sprayer 3 labourers were necessary to cover an acre, the operative cost per spraying being in the region of Rs. 6 to Rs. 6-50. We realised that at this figure, spraying could never be an economic proposition, and our efforts have been aimed in the direction of reducing costs to a minimum.

It must be borne in mind that tea recovering from pruning and tea in plucking present two entirely different problems. The leaves formed on pre-tipping growth must remain on the bush for a fairly long period and any reduction in that leaf surface must be to the detriment of the bush itself.

With this object in view, experiments were planned to give us the information as to —

(1) Minimum copper required for efficient protection,

(2) Intervals between sprayings,

(3) Ways and means of reducing application costs.

We are still at too early a stage to state what minimum requirement of copper is necessary for protection. We know that a suspension of 4 ozs. of Perenox in 10 gallons of water, applied at the rate of 12 gallons per acre, gives effective cover. At this new rate of application the fungicide cost which ranged from Rs. 1.75 to Rs 3 has been reduced to approximately 55 cents an acre. This reduction has been mainly possible, following trials with different types of nozzles which regulate the spray output of the Knapsack Sprayer. Low volume spraying is desirable because of the greater control of "run off" from leaves and the quicker drying of the smaller droplet size. It is unlikely that intervals greater than 7 days would be possible between sprayings, though during spells of dry weather this interval may be stepped up to 10 days. Spraying from budbreak to the 1st tipping may then require from 12 to 15 applications if pruning is commenced about the end of June in the South West Monsoon areas.

Apart from the question of the most suitable fungicide there is also the question of how the fungicide is to be applied.

On the size of the job in hand, depends the type of spray applicator necessary for efficient and cheap working. These applicators may range from flit pumps to helicopters. The use of aircraft raised many difficulties which could not be settled until expert advice could be obtained. We were then left to choose between large motor borne applicators, such as the TIFA, more portable power sprayers which could be wheeled or carried down narrow foot-paths and the most commonly used Knapsack sprayers.

You will no doubt hear Mr. Lane's and Dr. Greenslade's views on these problems. Our own views on the suitability of the TIFA machine under Ceylon tea conditions have already been expressed.

Earlier in the year we ordered from the "Four Oaks" Spraying Machine Company a battery of Knapsack Sprayers which consisted of 8 individual Sprayers and a central charge pump. This Knapsack differs from the better known "Four Oaks Kent" model in that the original charge of air remains throughout the day or week's operations. The advantages of this machine over the other knapsack sprayers is very apparent. One man stationed at the central charge pump keeps 6-12 men constantly spraying without any pumping action on their part. The men have both hands free to direct the spray and when the spraying liquid is exhausted they return to the charge pump, to take over a machine

which has been already filled for them. With this machine the operative costs have worked out at about Rs. 2.00 per acre. This figure includes only costs of material and labour plus dearness allowance ; it does not include supervision and depreciation of capital. As Mr. Lane will tell you more about this aspect, I shall not enlarge further on it.

I believe it will be possible with improvements to the central charge pump to step up the size of the battery, making it possible to spray a fairly large acreage a day.

The cost in the United Kingdom of these battery sprayers is at present £.7.15.0 for each Knapsack and £.35.7.6 for the central charge pump. At these rates a battery of 8 sprayers and a central charge pump would cost approximately £.97.0.0.

A portable power sprayer, The "Kingston II," ordered through Messrs. Drake & Fletcher, has only now arrived. It will be another two or three weeks before we can state our own views on that machine with any degree of accuracy.

To conclude, I wish to give you our views on the question of loss of crop due to Blister Blight attacks.

No doubt exists that on a very few estates which lie in mist belts, loss of crop must be reckoned at a fairly high figure, though under usual monsoonal conditions no reliable data is available. An experiment was opened out on St. Coombs in May of this year in a field which had been pruned in early December. The plot was an ideal one, as the first plucking on the 23rd of May, showed no infections on the flush. Rains commenced on May 9th, and at the plucking on the 24th June, 85 per cent of the flush in the unprotected plots, 7 per cent in the weekly and 16 per cent in the fortnightly sprayed plots were found to be infected. Today, 5 months after the commencement of the experiment, the contrast between the sprayed and unsprayed treatments is very marked. Defoliation above the tipping level has been severe on the unprotected bushes and the plucking table appears a mass of leafless stems. The protected plots, however, carry all their leaves and appear in very good health. The weekly sprayed plots have given 18.9 per cent and the fortnightly sprayed plots 18.1 per cent more crop than the unprotected plots. In the fortnightly sprayed series this represents a gain of approximately 11.9 lbs. per acre expressed as a dry weight of total picks after 12 spraying operations At the estimated figure of Rs. 2 an acre, for spraying, these 12 operations represent an expenditure of Rs. 24 to gain approximately 12 lbs. of manufactured tea To allow for a further negligible increase in crop but for a much finer control of Blister Blight, 25 weekly sprayings at the cost of Rs. 50 would be necessary. I must make it clear, however, that these percentage losses are for over the monsoonal period June to October of this year and cannot be used as a basis of calculation for an overall loss through the year.

Undoubtedly spraying of tea in plucking under these conditions will be uneconomic as costs of spraying operations, supervision and depreciation, together are above what may be expected from additional crop. On a long term policy, however, spraying results in healthier bushes, a benefit which it is impossible to assess in terms of hard cash.

Losses up to 40 per cent due to Blister Blight have been reported from at least two estates, one at an elevation of about 3,000 feet and the other at about 5,500 feet. On the estate at the lower elevation we have made arrangements to open an experiment on a large scale which would incorporate the different styles of plucking and protection, to give us an accurate impression of

the efficiency of the various agricultural methods we have so often recommended. You will appreciate however, that this experiment would have to be of fairly long duration for reliable data.

A final word on the blackening of Blisters which appears to be on the increase. In the first Blister year heavily infected fields appeared white with the blisters in full bloom, while now a blister is browned, even before it starts to spore or the white sporing period is shortened. The cause of this browning is the fungus *Colletotrichum camelliae,* better known as the causative fungus of Brown Blight. The fungus enters the leaf at areas weakened by the establishment of *Exobasidium vexans.* Unfortunately the fungus can cause even more damage than Blister Blight as infections on stem blisters may cause premature wilting and death of young flush.

Ceylon III. Agricultural Aspects.

G. B. PORTSMOUTH.

It has been arranged for me to address you at this stage in our proceedings in order to remind you, in the midst of all these discussions regarding spray protection, of the continuing need for the various control measures based on modifications of normal agricultural practices which have been recommended by this Institute to counteract the effects of Blister Blight. For those few of you who are not already only too familiar with these measures I propose briefly to recapitulate the main lines of attack available to us in the reduction of Blister Blight damage.

(1) Alteration of pruning times so that recovery takes place during the driest and most mist-free period of the year. During this recovery period every effort must be made to obtain the maximum development of healthy undercover foliage. This means that the maximum possible frame size and number of pruned points must be left, while tipping must be so arranged that no healthy mature leaves are wantonly removed.

(2) Alteration of plucking policy during periods of Blister Blight attack. This falls naturally into two phases depending on the type of attack. Thus with a leaf attack only, normal plucking procedure should be continued but the rounds must be closed up as much as possible. However, in the case of a severe stem attack the whole shoot will be destroyed and nothing will be left for the bush. Accordingly, *in this case only, and strictly for the duration of the attack,* it is recommended to pluck to the fish leaf. At the conclusion of a stem attack plucking must, however, be stopped for a few rounds and the bushes allowed to make up for all the maintenance foliage lost.

(3) Good health is largely a matter of good nutrition. This truism applies equally to plants as to men and may be best interpreted in the present case as an injunction to ensure that adequate manure is available to enable the bushes to make all the growth they can when such growth is possible.

(4) Control of shade in areas such as fine weather mist pockets and on western facing slopes.

(5) The establishment of Blister Blight resistant clones.

Now a word or two about pruning. In areas which receive both monsoons pruning into the dry weather generally means that all pruning has to be concentrated into the months of November and December. This means that crop is lost during the quality months of March and April while there is a still further loss on account of the slowness of recovery in this dry period. In the previous two years the North East Monsoon has been light so that little Blister Blight infection has been in evidence during this period. Accordingly there has been a tendency for pruning to be started progressively earlier in order both to take advantage of the quality months and to obviate the labour difficulties arising from the concentration of all pruning work into a very short period. Reports have, in fact, reached us of estates starting their pruning this year as early as July or August. Unfortunately the weather this year has ceased to be kind to us with the result that a heavy Blister Blight attack has again built up at the present time. As you will have heard from Mr. Loos it is quite possible to protect these pruned fields by spraying during the recovery period, provided always that the necessary equipment is available. This, I am afraid, is not the case, and in fact I have been given to understand that there is not sufficient spray equipment at present in Ceylon to provide protection for all the areas that may require it. This means that those estates which lack the necessary equipment are almost inevitably faced with the prospect of considerable Blister Blight damage as a result of their departure from the recommended time of pruning. However energetic their efforts at this late hour it seems very unlikely that spray equipment can be obtained in time to do much good. Operations which depend for their success on the continuance of certain specified weather conditions are always something of a gamble and this year I am afraid that a number of up-country planters will regretfully have to admit having lost.

Mention should also be made here of slope pruning and plucking now fairly generally adopted in South India. This has the great advantage that there is no overhang of one bush on another which, under our system of horizontal pruning, and plucking, produces local shaded areas in which the humidity remains high and so encourages the development of Blister Blight. Unfortunately the change over from horizontal to slope pruning is not an easy one to make since there is a very real danger of our present very poor bush frames being still further reduced by cutting away on the lower side to conform to the slope. This is a prospect that cannot be contemplated with equanimity, considering the very debilitated state of much up-country tea and for this reason alone slope pruning has not previously been advocated by the Institute. Needless to say the change over can be made, but it must be accomplished in easy stages by both pruning and tipping at a higher level on the upper side of the bush only.

I would now like to turn to a rather more cheerful subject, namely, the selection and vegetative propagation of Blister Blight resistant clones. This has already been carried out with considerable success both at the Tea Research Institute and on a number of estates and can, therefore, be very definitely said to have reached the practical stage. Here a few words concerning the right type of material for selection may not be out of place. Put in a nutshell the essential qualification required of a good mother bush is that it shall continue to yield well even during a severe Blister Blight attack. Looked at rather more closely this means that the bush must not only be of a vigorous high yielding type but must also display a considerable amount of Blister Blight resistance as

otherwise it would fail to yield during a severe attack. This then is the obvious time to select mother-bushes for propagation. Of course, in addition any selected bush must also be a good rooter in the nursery and capable of producing good quality tea.

It will be noted that no recommendation is made to look for completely immune bushes. *Immune* bushes are comparatively rare and even when found, prove, in most cases to be poor jat, low yielding types. However, this is not to say that high yielding, good jat, immune bushes do not exist and such estates as do possess them are indeed fortunate.

One final word regarding supplying. In many bad Blister Blight areas the continuation of supplying from seed would often appear to be quite useless. It is perfectly possible to protect the seedling plants in the nursery by spraying but once they are put out in the field further protection often becomes impossible and the majority succumb to Blister Blight attacks. Many of you will, no doubt, have had actual experience of this happening. Accordingly, in these areas I would much prefer to see all supplying carried out with Blister Blight resistant clonal material. What to my mind is important is not the number of new supplies which are put out each year, but the number which are successfully established in the field.

In conclusion I would again like to remind you all that, until such time as a full scale programme of protective spraying has been decided upon and is actually in operation, we cannot afford lightly to disregard any of the possible agricultural controls available to us.

S. India I. Present Position and Control

S. ANANDA RAU.

At the outset I must mention that as conditions in South India are not entirely dissimilar to those obtaining in Ceylon, much of what I have to say will perhaps be repetition of what you have already heard from the speakers who have preceded me. Nevertheless, these repetitions, I venture to think, are to be looked upon as supporting evidence for any views expressed and I therefore make no apology for them.

Since the appearance of the disease in South India in the latter part of 1946, we have had the opportunity of watching critically the course of the disease for a period of 3 years. This has led us to suppose that, barring minor fluctuations, the disease generally occurs in waves, of which 3 could usually be recognised during the season of disease activity in areas which receive both the monsoons. Each wave of attack results in a peak being reached, the first peak roughly in July, the second in September and the third in November. In 1947, the second and third peaks were higher than the one preceding it, but in 1948, the first was the highest but the wave was of short duration and the disease declined sharply due perhaps to the very wet conditions experienced at the time. The second and third peaks reached rather less damaging levels though the waves were of longer duration. In 1949, probably as the result of exceptionally severe and prolonged drought experienced in the early months of the year

and the consequent small 'carry over' from the previous season, the attack was slow in building up and the first peak was reached only about the 19th of August. The intensity of attack was of a lower level than that of previous years. The second wave started about the beginning of October and reached a peak towards the end of that month after which a decline has been noted. It seems unlikely that a third peak will ever be reached this season unless the weather conditions hereafter prove abnormally wet and favourable to the fungus. This refers to the incidence of the disease on the Experiment Station, but it may vary somewhat in the different districts. I mention this, because correct appreciation of the periods when the disease is advancing and when it is receding should help to organise the rounds of close plucking and to minimise crop losses.

The incidence of disease and the extent of its damage have varied from year to year and from district to district. Even within a district considerable variation in intensity of attack is noticeable and this is governed by the topography of the area, the condition of the tea, and the environment. Generally speaking, high elevation estates have suffered greater damage than those situated in mid and low elevations and Mr Mayne will no doubt speak presently on the disease position on the High Range.

In the mid and low elevation estates, I will not be far wrong if I say that the disease position this year has been one of improvement over the previous two years. In view of the very severe drought the disease was slow in reaching the level of causing economic damage and this was so despite the early onset of the monsoon. It is felt that in the present year crop losses due to Blister Blight attack, although difficult to assess, have not been of the same order as those of 1947 and 1948 and reports from estates generally indicate a satisfactory crop position. The improvement is attributable partly to seasonal conditions and partly to attention to pruning and plucking and to regulation of shade.

In one or two districts in S. India, the advent of Blister Blight has brought in complications, the long term effect of which, it is feared, may upset stability. Firstly, I refer to what is known as 'defoliation' which is prevalent at elevations of 2000 feet to 3500 feet. There is reason to believe that successive attacks of Blister Blight have brought the condition of 'defoliation' into greater prominence and as these elevations are on the border line of carbohydrate deficiency, the bringing back of tea with 'defoliation' symptoms to a reasonable state of health may take very long or may even be impossible if Blister Blight attacks persist.

The second is the effect of Blister Blight on tea in districts subject to serious *Helopeltis* attack. Unfortunately Blister Blight too occurs in severe form there so that grave concern is felt as to what the combined attack of both pest and disease may ultimately lead to. Fortunately, reasonably successful control of *Helopeltis* with the use of D.D.T. is now within the reach of ordinary estate practice.

As regards control, direct methods of combating the disease have still remained a remote possibility. Spraying of tea in bearing being out of the question for obvious reasons, amelioration is naturally sought for by modifying the cultural practices. Pruning is invariably done during the dry weather and this has proved to be the most effective means of minimising damage. Shade regulation has been the next important step undertaken though, unfortunately, cases have been met with where this has been overdone.

Regarding plucking, an experiment involving 3 different systems of plucking has

given us results which show that continued hard plucking throughout the Blister Blight season compared unfavourably with the other systems and produced significantly less crop. There was indication, however, that the incidence of disease was somewhat less with hard plucking, but much reliance cannot be placed on this feature as the method of recording the disease incidence on the basis of shoot counts leaves much to be desired. The results of this experiment do not, however, call into question the value of 'close' plucking at carefully selected periods during the Blister Blight season. There is, however, the danger of 'close' plucking accentuating carbohydrate deficiency which occurs even up to an elevation of 4,500 feet in South India, unlike in Ceylon where the danger limit is placed at 3,500 ft. Indiscriminate 'close' plucking should therefore be strongly resisted.

For the protection of nurseries and for tea coming in from pruning, spraying has been found useful. Stunting of growth of young plants as a result of frequent spraying with copper fungicides has occasionally come to notice, but if proper care is taken to avoid excessive application of the spray fluid, this trouble can be overcome. Dusting with Perelan I, a copper dust, was tested in the nursery but it did not give the same degree of protection as that afforded by wet spraying with Perenox.

We have now in progress a spraying trial in a bed nursery with various fungicides. Seven different fungicides are being tested and these include two 'organic' ones, viz., Dithane and Fermate. The results to date indicate that Dithane is less efficient than copper fungicides, its efficiency being only about 8.1 per cent of that of Perenox. Trials with Fermate have not progressed sufficiently long, but even this product does not seem to approach the efficiency of copper fungicides.

Spraying equipment suitable for large scale spraying of tea in bearing is a problem which is as important as finding a suitable fungicide formulation. Apart from hand-sprayers, pneumatic and otherwise, and pumps of the D.S.P. type, we have not tested any power sprayers in tea. The practical difficulties in the way of transporting heavy machines in tea on hill slopes put out of court the use of power machines now on the market and it may be pertinent to quote here the extracts from the report of the Plant Protection Sub-Committee of the U.P.A.S.I. made in February, 1948.

> "We suggest that the main difficulties of the problem (spraying) are most likely to be overcome by the use of small unit machines *at* the working points to allow for more precise application, combined with mechanisation of the supply of water (or prepared spray fluid) *to* the working points, thereby avoiding a major part of the transportation. That is, mechanisation of the supply rather than mechanisation of the actual application. by pumping water or spray fluid from sources of supply to points where it is required for application. For this purpose we envisage portable power pumping units and rubber supply pipes.
>
> Organisation of the pest control gangs is obviously an important point in the most efficient working of a system based on this principle, but we consider that neither spraying nor dusting should be a specialist's job, for if it is to succeed in tea, it must be a task that the ordinary estate labourer can understand both from the point of view of the equipment he is using, and the technique of application."

A brief reference may now be made to the appearance of Brown Blight in association with Blister Blight. This was noted

for the first time towards the latter part of 1948 in several tea districts of South India and has also been seen during the present year. As no Mycologist is at present on the staff of our Station, extensive laboratory investigations on this question have not been possible, but such observations as we have been able to make confirm the findings of the Tea Research Institute of Ceylon that Brown Blight can at best reduce in some measure spore production of Blister Blight and to that extent it might be beneficial. We also share their view that the chances of its being used as a check on Blister Blight are very remote.

Before I conclude, I wish to refer to one other aspect bearing on the problem of control of Blister Blight, namely, multiplication of resistant clones by vegetative propagation. This only offers long term promise, but even so is well worth considering. It has been common knowledge that bushes exhibit varying degrees of resistance to blister attack. Selection of suitable material for propagation may well repay the trouble involved. We have found on the Station a bush which to all practical purposes is almost completely immune to blister. It was pruned for two years in succession in June and came into tipping without a single blister on the new shoots at a time when the neighbouring bushes were showing a heavy incidence of attack. This bush has proved to be a good rooter and clonal plants are being raised from the internodal cuttings. Some of these plants which are now over a year old have remained free of attack in the nursery.

S. India II. The Position in the High Range.

W. WILSON MAYNE.

The work done on Blister Blight in the High Range of Travancore has been concerned entirely with the seasonal behaviour of the disease, under the topographical and climatic conditions of the district. The area consists of a tract of some 200 square miles, all above 4,000 feet elevation, containing about 30,000 acres of tea. The rainfall varies from 300 ins. per annum in the West to about 50 ins. in the East, the two extremes being separated by a distance of not more than 20 miles. The majority of the estates are on the inner slopes of a dissected plateau bordered by ridges varying between 6,000 and 8,000 ft. elevation, but a few lie on the outer slopes to the North, South East and South West. The tea lies between the elevation limits of 4,000 and 6,500 feet. A system of regular reports from all the 38 estates in the district was organised in February 1947 four months after the disease first appeared, and these were maintained at weekly intervals for the first year, and fortnightly since. These reports formed the basis of a weekly or fortnightly report on a district basis, and suitably checked by a knowledge of the estates and the reporting managers, have been of very substantial value in studying the general trend of the disease in the area.

The major significant factor is, of course, the climate and it is necessary to note its main characteristics. From the point of view of blister blight, the major factors are (1) the general occurrence of a dry season normally extending from January to March and affecting the whole area ; (2) the occurrence over more than half the tea area of a continuously wet South West

monsoon in the three months June, July and August. In this period, in the wetter part of the area, it is not unusual for rain to be almost continuous for weeks on end, and as far as the bearing of the rainfall on disease is concerned, practically all estates whose annual rainfall exceeds about 100," are on much the same footing. The remainder of the year, i.e. April and May and September to December, is showery, with short periods of heavy and continuous rain in September and October. These periods of heavy rain are usually, though not always, associated with North East monsoon conditions and are somewhat more marked in the easterly, drier, half of the district. The large differences in rainfall are mainly due to differences in the precipitation in the South West monsoon months.

From the point of view of the disease behaviour, the 38 estates fall into 4 somewhat unequal groups. The main group comprises all the estates lying within the plateau with annual rainfalls over about 100 ins. There are 23 estates in this group, and although there is naturally quite a range of variation in the severity of disease outbreaks, the general pattern of the disease behaviour is similar. There is a small group of 5 estates on the outer northern slopes which is greatly influenced by the low-country below them, and although the rainfall is about the same as the drier estates in the first group, the behaviour of the disease is markedly different. The difference is especially noticeable in the case of one estate, the greater part of which lies topographically in the first group and is included there, but has one division which qualifies by its position to fall in the second. A third group of five estates in the east of the district with total annual rainfalls between 50 ins. and 90 ins. show a different, but variable pattern of disease behaviour, while the fourth group of four estates lying on the outer slopes to the South East also shows a rather variable behaviour, bearing, however, a relation to that, exhibited by the second and third groups. In the three latter groups the influence of elevation and proneness to mist play a significantly more important part than they do in the first group.

When the disease first appeared, it was hoped that a determined attack in the dry season could eliminate it or at least reduce it to such proportions that its rate of recovery would be slow enough to reduce the damage to negligible proportions. We had the experience of coffee leaf disease, which, while it was largely responsible for the disappearance of coffee from Ceylon, and the more southerly parts of South India, failed to eliminate it in Mysore and Coorg, where the droughts were severe. Blister blight seemed even more susceptible to unfavourable weather than coffee leaf disease, and it was thought that possibly a drought less severe than that normally experienced in Mysore and Coorg would be adequate to reduce the disease to an unimportant level. It so happened that the drought failed in 1947, showers fell at intervals which were almost ideal for the continued survival of the disease — the longest interval between wet days at my rain gauge, which is reasonably representative of the first group of estates in the High Range, was 25 days. In 1948 and 1949, the droughts were severe and rainless periods of 78 days (excluding one shower of 8 cents) in 1948 and 80 days in 1949 were recorded. These have shown that while the drought has a marked effect on the rate of recovery of the disease from the minimum reached in the dry weather, its effects do not extend beyond July. In the case of coffee leaf disease in Mysore the influence of drought is clearly marked right through the period of disease activity until drought again introduces a check. The difference rests on the extremely rapid rate of increase of Blister

Blight once the disease has spread initially from the minimum.

In estates of the first group, the climate imposes a very definite pattern on the development of the disease, and although, we have so far only three seasons experience, the main outlines of this pattern are clear. These can best be considered from the position reached in the middle of the droughts of 1948 and 1949.

At the time — say mid-March — the disease had reached a very low level. On ordinary planting standards most estates reported complete freedom from infection, but there is no question that the disease survived in favourable sites, since new infections were always reported within about three weeks of the first showers, usually in the neighbourhood of sites which would be expected to offer favourable conditions for survival. In both 1948 and 1949, the first reports of revived activity after the first April showers, came from the same group of estates on the extreme West. These all provide a number of sites favourable to survival ; heavily shaded jungle edges, narrow valley bottoms near streams, and so on.

Vigorous efforts were made in 1949 on two estates to deal with these survival areas, by hand collection in the dry weather, and where possible by dealing with the environment. On one estate the routine spraying of survival areas was undertaken. The tentative conclusion—and it obviously can only be an opinion — was that a little delay was imposed on the disease, but the effects were only temporary. The two estates in question were those on which the disease developed earliest both in 1948 and 1949.

There is no question that the droughts of these two years delayed the attainment of economically significant attacks by about a month, compared with 1947. In 1949, a system of flush counts at each plucking of selected fields, in each estate, was initiated towards the end of the dry weather, and continued for subsequent months. While one or two estates recorded mature infections in the harvested flush about three weeks after the first rains, there were estates where definite evidence of persistence of active blisters during the drought was available. On those estates with a record of no infections in the drought, the first signs of infection in the flush were rarely earlier than mid-May — fully six weeks after the first rain — and frequently as late as early June, although several records of odd infections below the plucking level were sent in about the third week of April. It was not until the second half of June that the attack reached economically important dimensions, and again, this level was reached first in those estates where survival centres in the drought were known to be considerable. The general peak of the attack was not reached until early July. In 1948, the peak was attained about the same time, although the first rains were slightly later (13th April instead of 1st April) as also was the onset of the South West Monsoon.

Under the very wet conditions normally experienced in June and July in the western group of estates, the only checks to the disease are the reduction of susceptible tissues resulting from the damage done by the attack, or from the very marked reduction in growth which is associated with the continuous rain, low light intensity, and low temperature. A characteristic feature which also tends to bring the disease to a standstill, is the very general occurrence of premature decay of blisters as a result of secondary invaders such as Brown Blight. This has been noted by numerous observers since the monsoon of 1947.

The result of the reduction in growth, loss of susceptible tissues, and decay of blisters prematurely, is that the disease

reaches a second minimum in August. There was a period in August 1948 when healthy blisters were as difficult to find on some western areas, as they were at the height of the drought.

With the lightening of the South West monsoon at the end of August and early September, renewed growth begins and as the susceptible tissues increase so does the disease. From the point of view of damage by the disease, the main factor appears to be the climate of September. In 1947 and 1948, following a very wet August, the first noticeable increased disease activity occurred about mid-September, but in neither year was it of serious direct importance. A further period of increase occurred in both years about the second week of October, but its effects were strikingly different in the individual years. In 1947, the cool wet September had delayed growth considerably, the October attack did very serious damage and the crops of October and most of November were poor. In 1948, a brighter, drier September facilitated growth, and the October attack failed to prevent the harvesting of a record crop in what is normally one of the best cropping months in the year. It also seems probable that the lower number of rainy days in September had a direct effect on the amount of infection which became visible in early October.

A further increase in the disease was noted in November, but was of rather lesser consequence in 1947 than in 1948. A dry November facilitated new growth in 1947, and checked the disease, giving rise to quite exceptional crops in December and January. On the other hand, in 1948, the slackening of growth after the rush of late September and October, and some continued disease activity, resulted in poor crops in late November and December.

In 1949, following a much milder August in which the elimination of susceptible tissues, and of the fungus, was much less complete, and the resumption of growth was earlier, a very sharp attack developed in the last week of September which, together with the cold wet weather during the month, played havoc with the October crop. This attack died down in October and the reduction of susceptible tissue was great enough to bring about a period of low activity, during which some recovery growth took place. At the time of writing there are some local indications of reviving disease activity but not on a very serious scale, and the crop prospects for late November are fairly good.

Apart from the activity of the disease in December and January 1946-7 just after the disease appeared, subsequent years have generally shown a decline in the incidence of the disease at this time. Much of the alarm engendered in the first few months, arose from the existence of a considerable amount of tea in a stage of recovery between bud break and tipping, which was very heavily attacked. With the adjustment of pruning times to secure dry weather recovery, this type of damage is less likely to occur in future, although it must be admitted that December 1947 and 1948 have both been drier than average.

The remaining three groups can be dealt with more summarily. The most striking feature is the relatively slow recovery of the disease in the period April to July. This is most marked in the second group of Northern estates, and it appears that the warm dry air currents rising from the heated plains of Coimbatore, exert a discouraging influence on the activity of the fungus, since the rainfall is not markedly different from the drier estates of the first group ($\pm$100 ins.). In this third group, the lower rainfall in June and July, together with the high winds of this period, appears to check the disease. In the driest of these estates, one division did not record infection

in the flush until the third week in August in 1949, except in portions of tea much subject to mist, the remainder showed low levels of activity until well into August. In the fourth group, both lower rainfall and warm air currents would appear to operate in delaying attacks except at the highest mist prone sites.

These three groups generally tend to experience major attacks only in the latter part of the year from October to December. The higher areas, subject to heavy mist and dews in the colder months, often show persistence of quite considerable activity into January even in the absence of rain.

This review of the course of disease development indicates that the main periods of damage, are in the Western areas, July and September-October and in the remainder, October to December. As far as recovery from pruning is concerned, there is little danger to be apprehended if it is possible to concentrate recovery between January and May. Our present pruning programmes are all designed with this end in view.

On the whole there appears little risk of serious crop loss in the April-May rush when this follows a reasonably definite drought. There is, however, no question that crop is lost in July-August although these are not heavy cropping months. The average July-August crop between 1941 and 1946 represented about 10 per cent of the total annual crop, and I estimated that in 1947 and 1948 the crop of this period was reduced by about 30 per cent. The main period of serious damage is in the second main crop period, normally extending from about mid-September to mid-November, but it is extremely difficult to assess the loss, and especially so since the onset of Blister Blight coincided with the commencement of a regular fertiliser programme on the estates with which I am concerned.

The problem from a plant protection point of view resolves itself into the question: Can the attack which is liable to develop between, say, the last week of September and the middle of October be postponed by, say, six weeks to afford a reasonable opportunity for the main post monsoon flush to develop and be harvested? At present we are relying largely on the management of plucking to harvest leaf before the disease reaches a damaging level, but there are many difficulties in securing the best use of this method.

Success of either a direct attack on the disease by plant protective methods, or indirectly by plucking management is obviously dependent on accurate forecasting of the future course of the disease. This in turn depends on the accumulation of data on the relation between the disease and climate, and I would suggest that this conference might consider the question of the establishment of a common basis for recording Blister Blight fluctuations in relation to climate, since whatever developments in control may occur, apart from those associated with the use of inherent resistance, the accuracy with which disease development can be forecast will remain fundamental.

The sketch I have attempted to give of what appear to be the key periods in the Hight Range, has been based on qualitative reports and their interpretation has only been possible in the light of a fairly detailed knowledge, both of the estates and the Managers. The flush count method adopted to follow the course of recovery of the disease from the minimum in 1949, is not as yet entirely satisfactory, although I do anticipate useful results from their tabulation. What seems to me to be required is a recording system associated with meteorological records which can be undertaken at a limited number of sites under skilled

control, the records from which should be reasonably comparable, and which can form the basis of a predictive system in terms of climatic variations. While we have a fair idea in a general way of the effect of climatic factors on the behaviour of the fungus, an increase in precision will be fundamental to any form of control whether direct or indirect.

N. India I. The Position in N. E. India.

E. HAINSWORTH.

Read by C. J. Harrison.

I am very glad indeed of the opportunity of attending this Conference. I feel however that your interests would have been better served, had it been possible for Mr. Hainsworth, our Mycologist, to attend instead. He has, however, prepared some notes for me, which I trust you will find of interest and help to you.

The control of blister blight on our tea has baffled the ingenuity of investigators since the disease was first described by Peal from plains-grown tea in Upper Assam in 1868. Forty years later, during which time the disease had been entirely confined to the tea districts of Upper Assam, it appeared suddenly on hill-grown tea in the Darjeeling district some three hundred miles to the west of Upper Assam. From that time onwards the importance of blister blight on plains tea appears to have dwindled and outbreaks have been sporadic, although it has always appeared somewhere each year. But in 1948 we received many specimens of leaves, affected by Blister, from plains estates. In 1949 the disease has been reported from each of the eight tea districts. A commentary on the more general reappearance of the disease in the Assam Valley is, that many of our senior planters have sent in specimens of affected leaves with the question "What is this ?"

It is fortunate that the annual outbreaks of the disease in North-East India have never been of long duration : outbreaks may occur in November-December, and again from March to May but are normally confined to April only on our plains tea. We ascribe its increased distribution during the past two years to the fact that both in 1948 and 1949 we had most unusually wet and cold weather in April, which this year persisted during May. During April and May also our seedlings have begun to grow, and we have the maximum amount of succulent young growth on our mature tea, the vast majority of which is pruned annually during December and January.

Even so, considering our plains-grown tea, the annual loss incurred by our industry as a result of attacks of blister blight is at present quite negligible. This statement must be qualified at once however, by the statement that we fear the potentilities of blister blight more than those of any other disease or pest. We have found tea leaves affected by the disease, on some plants which had been left to grow up and had been choked with dank vegetation, on our own experimental Station at Tocklai, for the first time on record in 1949. We have a discontinuous sheet of tea stretching from Darjeeling to Sadiya 400 miles long, and it is quite conceivable to us, that on the

next occasion when we have wet and cold weather unusually prolonged in the early part of the year, that Blister Blight may sweep through our tea, and cause severe damage to the early growth, even though it should disappear in the hot months.

To make this picture of the potentialities of the disease complete it should be added that in the Darjeeling forests we found three plants last year carrying *Exobasidium* fructifications, and one of these plants at least, *Camellia drupifera,* carried *Exobasidium vexans,* last year. Again this year, from the Khasi and Naga hills, which run up the centre of Assam and divide the tea-growing areas we have received specimens of plants collected in primary jungle bearing Exobasidium pustules. *Exobasidium vexans* was also found on *Camellia drupifera* in the Khasi hills as long ago as 1911. And as no estate in North East India is more than 50 miles from the hill forests, it is clear that we have a constant source of infection. Blister blight is known to persist through the year in the cooler conditions of the hill forests, and the potential danger to plains tea whenever plains conditions become favourable to the spread of the disease can never be removed.

In dealing with outbreaks of blister blight on our estates, we depend on two principles to reduce the severity of the attack, both of which are well known to the conference.

The first principle is, the spraying of tea leaves at frequent intervals with a fungicide. In practice we lay down that a Copper fungicide (such as Perenox or Copper Sandoz) should be used at intervals of 7 to 10 days from the time when blisters are first seen until the end of April, or longer should cold wet weather continue up to May. Clearly it is impossible to treat an entire estate in this way, and we have laid down the following order of priority in spraying.

1. Youngest tea newly germinated.
2. Tea up to one year old.
3. Medium pruned tea (every 15 to 20 years the height of the permanent frame of tea bushes is reduced by about 10-15 inches to compensate for the annual increase in height of ½ in. to 1 in. of new wood left after pruning : the resultant growth is very succulent and easily takes blister).
4. Young tea 2 to 5 years old.
5. Other tea.

Our second principle is directed at permitting the minimum amount of young succulent growth on the bushes at the time epidemic outbreaks of the disease are expected. The South Indian and Ceylon antecedents of this principle will no doubt be recognised. It is difficult to modify the times of pruning, which are fairly rigid, and as yet the situation does not demand it. But in the case of medium pruned tea, we have found that by executing the prune in September, so that it comes away early, and then, should an attack of blister appear, breaking off the top two leaves and bud by hand from every shoot irrespective of whether the shoot has reached the 'tipping' level or not, the stem and lower leaves tend to harden more quickly and we have very few stem blisters. By the time the axillary buds emerge the attack has usually faded out, and the lateral shoots are then tipped as they reach the tipping level.

Over and above these systems, we often find that an outbreak of blister blight on an estate is traceable to some old abandoned tea, particularly where the prevailing wind passes over it before reaching tea in bearing. The opening up and clearing away of such tea is of obvious importance. The association between blister blight and fields of tea surrounded by thick jungle is also often well marked.

The situation can be summarised by saying that, in Assam, blister blight is not

a serious problem on mature tea in bearing, but occassionally causes damage to nurseries, young tea and medium pruned tea, on which outbreaks are treated by spraying with a copper fungicide.

The problem on our hill-grown Darjeeling tea is rather different. Blister blight is normally present in Darjeeling from May to October, and in this district damage may be locally severe, particularly on tea which is producing succulent growth following a cut-back at the end of a 3 or 4 year cycle, and in areas surrounded by forest, and shaded re-entrants.

Under these conditions, it has been found by Macalpine this year that a single round of spraying with Perenox in July, followed by a second round 14 days later, gave excellent results, so that close-plucking on short rounds, which had been adopted when the attack became serious at the beginning of July, could be discontinued and the bushes allowed to put on one to three permanent leaves.

The principles of the application of such fungicides are open to several objections and I now want to consider some of these.

1. The efficiency of a copper fungicide begins to fall off from the moment the act of spraying is completed for the following reasons.

(a) The fungicide may be chemically unstable.

(b) It is washed off by rain.

(c) The plant grows out of it, so that the youngest and most vulnerable parts of the plant tend to be almost always untreated.

2. The effect of continued applications of copper to tea foliage is neither desirable nor beneficial.

3. The first application during an attack is always 10 days too late, since the first blisters are already sporulating when formed, and there is nothing to indicate in which direction the spores have been carried.

4. It is economically impossible to spray all the affected tea on an estate at 10 day intervals.

5. Even when applied weekly over a long period, it has been shewn both in South India and Ceylon that only a partial reduction in the number of blisters over unsprayed tea is obtained, and never complete control.

[Recent experiments in Ceylon have shewn that a very high degree of protection is *possible*. —Editor.]

What then are the alternatives? The search for resistance must obviously continue unabated. It has already been shewn however that resistance in a mother bush is not always maintained in clonal plants raised from it, so that the time when all of today's existing tea is replaced by tea which is genetically immune is by no means at hand. Even when that day arrives, it may not be the end of all troubles, since there is already a growing suspicion that the fungus throws mutants of varying pathogenicity. In instance of this one may quote the experience of Gopalan who found that two bushes in the High Range which remained resistant for two years whilst all those around them were attacked, suddenly went down with severe blister. The history of plant breeding for varieties resistant to disease is full of such cases. In North East India we have in our minds, too, the possibility that this sudden increase in blister blight may be traceable to such a cause.

To me, it appears that the next real step forward in the control of blister blight must await the outcome of work on some of the newer aspects of plant chemotherapy. I refer to the use of systemic fungicides, which could be introduced into the tea bush

by being sprayed on to it, and which would produce in the bush a transient immunity of sufficient duration to see it through an epidemic.

The idea is basically more sound that that of the copper spray, but to develop it with special application to the problem of protecting the tea bush against blister blight would need considerable fundamental research. I submit that it is for the tea industry to consider whether it ought not to subsidise research into this problem in a University.

Laboratory work at Tocklai on blister blight control has not been possible hitherto, because in the past, supplies of fresh infected material could not be transported to the station quickly enough. When Tunstall brought down supplies from Darjeeling in vacuum flasks the spores were found to be no longer viable on arrival here. Even now when it is possible to get fresh blisters in the laboratory, there are only a few weeks in the year when, unless special apparatus is to be installed, physical conditions, especially temperature, are favourable for the growth of the fungus in the laboratory. The lead in the laboratory investigations therefore must inevitably come from elsewhere, and we look particularly to Ceylon for this. In March and April of 1950 we propose to determine the susceptibility to blister blight of the seven types of tea recognised by Wight ; such information may provide indications as to the direction in which true resistance may lie. We are, however, most anxious to play our part in any combined research programme conceived at such a conference as this, in which the various Tea Research Institutions may be asked to tackle different aspects of the problem. The value of such programme in work on pest and disease control has already been demonstrated in work on *Helopeltis,* when South India and ourselves carried out a joint programme in 1947, and 1948, in which they dealt with aspects of dusting of insecticides whilst we worked on the possibilities of spraying. The saving of time by these methods is shewn by the fact that efficient control methods for use on all types of tea-growing land have now been established.

Whatever the outcome of this conference may be, therefore, it is our hope that when the programme of future work is drawn up, our participation in it will be possible, and should it be decided that the conference will meet again in a year's time, may we be allowed to hope that the next meeting will be in Tocklai.

Sumatra I. The Position in Sumatra.

J. H. VAN EMDEN.
and
J. REITSMA.

The tea growing area of the Dutch East Indies is mainly concentrated in Western Java and in North East Sumatra, around Pematang Siantar — The distance between these two districts is 700 miles.

When we left Java, Blister Blight had not yet been found in the Island and was, as far as we know, still confined to the Siantar area. In this tea district there are 13 estates mostly adjoining and totalling ± 25,000 acres, ranging from 400 to 4,000 feet above sea level. Only 25 per cent of the tea fields are at a higher elevation than 2,500 feet, which we consider to be a critical altitude with regard to Blister Blight. All the figures given are approximate and only meant to give a general outline of the situation.

The whole plantation area was abandoned during the war and now we may distinguish between the fields which were left undisturbed and those where the tea and also the shade trees were cut down by the estate labour for the purpose of obtaining land for their food crops. The bushes in these fields survived this drastic operation and are now coming back surprisingly well. In the area which was left untouched pruning commenced in August 1947 and proceeded up till now. Because of shortage of labour thinning out of the shade trees could not keep pace with the pruning. As most estates have a system of continually planting young shade trees and removing the old ones when they are about 3 years old, it is clear that when the fields had been left to themselves for so many years the shade trees were not only too numerous but also too large. So, when Blister Blight made its appearance in Sumatra, probably in January, 1949, the situation was thus that there were fields of all ages from pruning, most of them too heavily shaded. Besides there were fields with no shade at all. Although the disease is now said to have been noticed in January 1949 for the first time, the Experiment Station was not informed until April 29th following because the disease was not recognised as serious. Regarding the way by which the fungus reached Sumatra we have no evidence whatsoever. Some are inclined to believe that air transport is responsible for its introduction, but considering the fact that coffee leaf blight (*Hemileia vastatrix*) also came from Ceylon to Java, before aeroplanes existed, there is reason why that theory should not be accepted.

When we visited the Siantar area in the first week of May, 150 acres were severely infested, and in 600 acres surrounding, blisters were sporadically to be found. Although eradicating the disease was not likely to succeed, an attempt to do so was made by pruning the severely infested areas and burying the prunings. The bushes were sprayed with Bordeaux mixture and all infected leaves below pruning level were collected by hand. Moreover, all spontaneous seedlings were destroyed. In the area where blisters occurred only sporadically, infected leaves were collected at intervals of 3 days. Besides a system of

plucking to the fish leaf every seventh day was adopted. Notwithstanding these measures by the end of May, 9 out of 13 estates reported to have found blisters and one month later every estate was more or less severely infested.

At the times we had the opportunity to see blister blight in Sumatra, the impression was gained that in shadeless fields below 2,500 feet the disease will be of no economic importance. Any shade, however, which prevents the bushes from drying up quickly in the morning, causes an appreciable amount of blister to develop. Even in the lowest fields the influence of shade is very marked. Over 2,500 feet, conditions are apparently so favourable for the disease that it remains to be seen whether any alterations of agricultural methods will check fungus development sufficiently to make tea growing possible without spraying Comparing the occurrence of blister blight in Ceylon and in Sumatra, one gets the impression that the fungus is much more dangerous in Sumatra than it is here. May be this difference is caused by the following circumstances :—

1. Sumatra grows only high jat tea with very few hybrids in between.
2. The system of selective weeding keeps the air between the tea moist.
3. The type of shade tree is different. For the higher fields of Sumatra, Albizzia is the most common shade tree and is allowed to develop a normal crown without being pruned to any extent.
4. With comparable days and inches of rainfall, temperatures in Sumatra will be approximately 10 degress F. higher than in Ceylon. To illustrate this with an example, we may show the following data.

Sumatra	July	Aug.	Septr.	Octr.	Novr.	Dec.	Jan.	Feby.	March	April	May	June
Siantar area 3000 feet.	4·68 9	3·0 5	9·36 15	7·04 18	14·28 22	12·88 20	16·44 19	7·84 13	5·28 12	13·08 22	17·21 20	4·88 15
Ceylon Edinburgh Estate. 5600 feet.	2·05 7	2·13 7	4·78 11	7·30 17	13·01 16	11·89 26	13·14 24	13·08 23	10·02 21	12·71 20	9·97 19	7·44 16
	Jan.	Feby.	March	April	May	June	July	Aug.	Septr.	Octr.	Novr.	Dec.

Siantar area 3000 feet.	Temperature	62°–82° F.	Average noon temperature	± 80° F.
Edinburgh Est. 5600 feet.	Temperature	55°–73° F.	Average noon temperature	± 70° F.

As to humidity in Sumatra even in the relatively dry months of July and August, 1949. moisture content of the air was on the average not below 80 per cent for more than 8 hours and not below 60 per cent for more than 2½ hours a day.

To control the disease, humidity in the field must be lowered and the building up of the disease must be slowed down. Humidity can be lowered, at least in the dry season, by removing of the shade and by keeping weeds down. Building up of the disease can be retarded by close plucking at short intervals so that little susceptible material is left on the bush and blisters are removed before they ripen. As close plucking at short intervals cannot be maintained for a long time without seriously weakening the bushes, the fields will have to be rested periodically. During the resting period the new flush will have to be protected by a spray. In addition to this, pruning will have to be timed, so that the most sus-

ceptible fields will recover during the dry period. This timing of the pruning however cannot in Sumatra be expected to be very effective as the dry seasons are rather short and cannot be relied upon.

As slight differences in environmental conditions may produce great differences in intensity of the disease, it is being attempted to find out which are the minimum requirements for the fungus to increase rapidly. For this purpose Dr. W. F. van Kell of the A.V.R.O.S. Experiment Station who is now in charge of blister blight work in the Siantar area is collecting data on humidity and temperature at various levels up to six feet above the ground in fields situated at different elevations and varying in density of shade. Collection of these data is especially important because we hope it may give us a lead as to how much shade can be left and what microclimatic conditions must be attempted to arrive at. Also these records may enable us to forecast which fields will be most susceptible when the disease will have reached Java.

As to spraying we immediately decided that spraying with the then available hand sprayers would be inappropriate because of the low pressure at which the fungicide is discharged and because of the intensive supervision that would be needed. The only kind of handspraying equipment which might give a suitable spray was considered to be a pressure retaining, knapsack model, but on account of the large area to be treated, we advised the companies concerned to send an agricultural expert to Europe and the U.S.A. to study the most modern spraying equipment and to buy such machines as would be suitable to be used in the tea fields. This expert recently came back from America having bought $.10,000 worth of equipment being 17 portable mistblowers and 3 jeep mounted machines. The portable mistblower weighs 150 pounds and is said to have a capacity between 3 and 6 acres per hour and a range of 30 feet. The jeep mounted apparatus weighs 700 pounds empty, has a tank of 42 imp. gallons, an engine of 10. h.p. and will discharge 6,400 cubic feet of air at a velocity of 190 miles per hour, through an outlet of 12 inches. The range is said to be 100 feet and the capacity 10 to 20 acres per hour. The machines have just arrived and have not yet been used, so we cannot say whether they will prove to be a success or not. The expect warns us in his report that wind will seriously interfere with mist-spraying and that personnel will have to receive a thorough training before they will be able to operate the equipment efficiently.

Besides the control measures just mentioned, attention is being paid to finding of resistant varieties. A number of selected clones have already been sent to Sumatra to be observed for resistance to Exobasidium. One will always have to go on looking for resistant bushes and should never plant large areas with one clone as the fungus may in time get adapted to a clone which used to be resistant as in known to have happened in case of the South American leaf blight of Hevea.

At the end of this lecture, I want to express our sincerest thanks to the Tea Research Institute and to all planters who spared no time and effort to enable us to study the behaviour of blister blight in Ceylon. Co-operation between Ceylon and Java has in the near past borne highly beneficial results. We need only recall the suppression of tea-tortrix in Ceylon by introduction of *Macrocentrus homonae* from Java in 1935 and the various reciprocal visits of experts. We can only hope that this co-operation will be maintained and intensified to the benefit of both countries.

3. Agency House Views on the Blister Blight Situation.

G. K. NEWTON.

(Read by L. E. Baker.)

I much appreciate the opportunity given to me by the Director of the Tea Research Institute for expressing the views held by Members of Agency Houses on the Blister Blight situation as it has arisen to affect the Tea Industry in Ceylon. It is with the greatest regret I have not found it possible to attend the Symposium personally, but my colleague, Mr. L. E. Baker, has very kindly consented to read this paper, the contents of which are based on views expressed by Members of a number of Agency Houses and General Managers of Companies representing views I would have expressed if made as a personal contribution only.

The Secretary of the Planters' Association was good enough to circularise Agency Houses, etc. (34 in number) asking for expressions of opinion on this subject many of whom have assisted me with their written views which I much appreciate, and gratefully acknowledge in compiling this memorandum.

I believe all present are aware that the fungus manifested itself in this Country towards the end of 1946 when great concern was occasioned by its arrival, and, except for academic knowledge at that time, nothing was known here of its habits and activities, nor could anyone judge how it might affect the Tea Industry in Ceylon for the future. Since then several outstanding features have established themselves, showing how the Blight affects Tea in varying degrees in different parts of the Island, at different elevations, and even varies in its intensity between adjoining estates, and adjoining tea fields, according to their situation in respect of rainfall, mist, and exclusion from the rays of the sun, etc. These are points of an agricultural nature, which are being dealt with more specifically by Mr. Kenneth Morford, but I would emphasise here that the general view held is that Tea planted in the Low Country (say, up to 2,000 ft. above sea level) attacks of the Blight so far have not given cause for much apprehension nor have we received any reports of probable crop losses from estates so situated. For what is known as the Mid-country Zone (2,000 to 3,999 ft.) the intensity of attacks seems to vary very greatly according to the situation of the fields, but there is a general feeling that crop losses in these areas have now become serious amounting to between 5 per cent and 10 per cent. For the Up-country Zone (4,000 feet to our highest tea a little over 6,000 feet) the losses appear to be even greater, in this case estimated at between 5 per cent to 20 per cent, according to the situation of the fields.

The above computations refer to estates which receive rainfall from both the South West and North East Monsoons and as far as tea estates in the Uva District (where rainfall is only heavy during the N. E. Monsoon period) liability to Blister Blight attack appears to be less, with the exception of some of the highest Tea which lies in the Mist Belt. On the whole, opinion is that this area of tea is not suffering as severely as that planted in the S. W. Monsoon dis-

tricts, except perhaps for some sporadic and very acute attacks.

From figures at my disposal no indication is given of crop being lost from this area, but it is quite likely that some individual properties have been adversely affected for which there is no specific information.

Although it is generally admitted that losses of crop are taking place the Customs Returns of tea exported for the past 5 years are as follows :—

1944 - 273,453,894 lbs.
1945 - 230,042,976 lbs.
1946 - 290,511,908 lbs.
1947 - 287,259,020 lbs.
1948 - 296,000,174 lbs.

which figures appear to contradict the general assumption, but I think to some extent the high total output since Blister Blight arrived has been occasioned by increased manuring on Low-country estates following greater availability of artificial fertilisers after the War, and resultant high yields from these properties not affected by the Blight ; a higher intensity of plucking on properties which have recently changed hands, and also increased yields from the Uva Province, where weather conditions have been conducive of good flushes and where manure applications have also been increased.

One also has to bear in mind the fact that heavy attacks of Blister Blight have a similar effect to a very light cut across and, with good weather conditions following, result in heavy flushes. This may tend to keep yields up for the time being on some properties but eventually must have a detrimental effect on the tea. Naturally Proprietors and Shareholders are concerned with falling crops, and to what extent such a fall may affect their dividends, the allocation of sufficient reserves for future requirements, and other allied factors. These important issues are of particular concern for Agency Houses.

It is generally admitted that cost of production has been increased on many properties figures given to me being between 2 cents to 14 cents per lb., with a few outstandingly high increases, the highest being placed at 44 cents per lb. Such a factor of course is responsible for reduction in profits, and there seems to be no doubt that Proprietors and Committees are suffering as a result. One of the repercussions can be seen in share price lists, where shares for Companies holding estates in the North East and Low-Country districts are very firm, whereas the same cannot be said of Companies where their main holdings are in the South West Monsoon area.

Visiting Agents generally have followed the advice of the Tea Research Institute in altering pruning methods so that bud break may not take place during very wet weather ; this factor seems to have become almost general now in the South West districts, but again is more an agricultural problem which Mr. Morford will be dealing with.

Where Agents are concerned over these evasive precautions is the way work on estates becomes concentrated for short periods, followed by slack periods when employment for all labour becomes difficult. Since there is a statutory obligation to give a specific quota of work weekly it often becomes necessary to "find employment" resulting in higher costs of production. Another repercussion of Blister Blight.

The use of fungicides in the form of sprays have been found useful in the treatment of young plants in nurseries, and on a few estates such prophylactic treatment has been carried out on tea recovering from

pruning. Reports of the work done so far indicate considerable variation in cost, according to the terrain over which the tea so treated is planted. Spraying of old tea in preventing Blight attacks is a subject which I hope will come in for much fuller comment at a later stage today.

One of the most important items for maintaining the Capital Value of a property has been tea supplying, which requirement has in the past been a regular feature of estate routine work. The arrival of Blister Blight has made the supplying of old tea extremely difficult and in some of the worst affected estates it has been given up as impractical. Since casualties amongst old tea are tending to increase rather than to reduction this feature is considered to be extremely serious and it is earnestly hoped some means of protection of young supplies from attacks of the Blight will shortly be devised.

Just about 10 years ago the Tea Research Institute commenced investigating the possibility of propagating tea plants by vegetative methods, at that time the main reason being a search for high yielding types having quality characteristics. Since then selection has been directed towards types having Blight resisting qualities as well as the other desirable characteristics, and the search for Blight resisting types of tea bushes has been attended with considerable success by a few Planters who have devoted a great deal of their time and thought to this subject. Propagation by the vegetative method using cuttings from Blight resisting clones may soon form part of the future programme of rehabilitation of a number of tea estates. This is a long term proposition attended by more difficulties than is normally appreciated. From the Agency angle the pursuit of this specialised type of planting is one we would like to see developed by Planters as quickly as practicable. However, the various steps for selection cannot be accelerated beyond certain limits since only the very best material for replanting and supplying will eventually be required and cost of the work is high. No doubt Mr. Morford will refer more specifically to the whole problem of vegetative propagation.

The above observations give only a very brief outline of the way Blister Blight has affected many tea estates in this Country, but I can assure all present here today that we who are custodians of the interests of those who have invested in the tea producing industry are extremely concerned at the way Blister Blight has affected tea in Ceylon and worried by our apparent impotence in controlling the fungus. It was on account of this concern that the problem was stressed some months ago at an Agency Section Meeting of the Planters' Association leading to steps being taken by the Tea Research Institute to attract advice by Specialists from England concluding in this important Meeting today.

4. PLANTING VIEWS ON THE BLISTER BLIGHT SITUATION.

KENNETH MORFORD.

My brother planters may wonder why I have been honoured by being allowed to introduce the Planting Angle on Blister Blight. There are two possible reasons — the first that a fool rushes in where angels fear to tread, the second that I have been too closely associated with the labour side of our industry for some years, and it has been thought desirable to turn my thoughts to the more productive side of our Industry.

As far as the planting angle is concerned, I think most planters find an endless circle a much easier description of their views. However, I have sought to put together a generality of views, and if some do go over well worn ground, I would reply that my endeavour is to link up as many facets of this problem as possible. First of all, as having the privilege of speaking for planters this morning, I must express the very real sense of gratitude we feel to the Director and his able body of Officers, with whom I include Drs. Gadd, Eden and Tubbs, for the very valuable services they have given to our Industry. Not only did they prevent scare and alarm developing when blister first attacked us, but by their really quick research and sound and practical advice, they saved us millions of pounds of tea, and ensured the security of employment of the half million or so employees who are so dependent on the Industry in these areas. Our thanks can never adequately be expressed.

Perhaps the most important question before us is "What is the ultimate fate of tea Up-country if blister continues on its present scale"? I allude particularly to those areas which lie in the mist zones, to a slightly lesser degree to those estates which while outside the mist zone have two monsoons, and lastly to those less affected estates on the Uva side which have only the one wet season to contend with. The first two areas have as much as eight months of anxiety, the latter area perhaps two short periods of a few weeks in which attacks may develop. Before enlarging on our problems I must ask planters to take their thoughts back a few years — prior to 1946 — when blister was unknown. What then filled our planting discussions other than labour; was it not phloem necrosis, pratylenchus, helopeltis, shot-hole borer, marioni, etc.? Jonahs of that time saw the end of tea looming near: to the older ones amongst us memories of tortrix served as a great encouragement and counterblast. But what was the T. R I. preaching? Their doctrine was plant selection, vegetative planting, and working for higher yields and better quality. Have we forgotten all this? I think some of us are tending to overlook those recent, "bad old days."

I think all planters feel that Blister Blight has heavily underlined the weakness already existent in much of our tea: the majority of casualties now occurring since blister came in are due to other causes accelerated by blister.

Plucking, the revenue producer, is perhaps the most debated angle: Dr. Gadd's lecture in Kandy, ably supported by other speakers, did very much to clear the air, and most will agree that the immediate result has been a marked improvement in plucking and in handling of the tea bush.

But it is often difficult for the planter with so many calls on his time to ensure that Meenatchie rings the correct changes in plucking to the best advantage of the tea bush at every change of the blister situation. We often wonder if proprietors appreciate the need for light handling of plucking, and even full resting of their tea, tortured by blister, when they see markets standing at over Rs. 2 per lb. I may be told that the first years of blister blight saw record crops of tea, to which I reply, that where that was so, it was due to improved manure supplies ; favourable weather ; and to the immediate, but temporary response which tea gives to a sudden removal of shade, coupled with an alteration in the pruning time. Now, I think most of us will admit to a loss of approximately 10 per cent of crop over the three years in which we have endured these attacks — some have lost more : but where records have been carefully checked with the data advised by the T. R. I., 10 per cent would seem to be a fair average.

I feel we would like to know more about this policy of resting tea. Is the best time to rest the non-blister period, and at what stage should tea be brought back into plucking — should it be cut across and at what height above the table at resting time ? Does blister appreciate Dr. Gadd's advice to keep hands well out of the area below the plucking table, do we lose a lot by stem attack below the surface and what do we do about it ?

Manuring would seem to come next in our problems. We hear of shortages of potash in our soils, and we are told to try and avoid terrific production of leaf at dangerous periods for blister. When then should we manure, and do our mixtures require a big overhaul so as to produce wood and encourage reserves of food, and should we apply at the optimum period as known by us from years of watching our estates : or must that go by the board as tending to enhance the main rush periods ? Again our optimum period usually coincides with our pruning time, now that we prune for a dry bud-break.

Green manure and shade are other problems : the T. R. I. anti-scare policy warned us against denuding estates of shade and green manures, and stressed complete control ; but are we wise to cut out so much before young plantings are well established? We would like more advice on the relation of green manures and shade to blister, should it be high or low, does a too rapid lopping of green manures tend to take out of the soil and give back little or nothing ? Do good mulches of grevillea leaves counteract the disadvantages of drip in the dew periods, and does a mulch retain humidity to a point that encourages blister to grow ? There is much hesitancy over the use of the grevillea, and also that other splendid tree the albizzia.

Directly arising from this matter of shade reduction, comes the serious defoliation and thinness of much of our tea when blister has been severe. This prevents the tea giving its own adequate protection to the soil, and most of us have found greater trouble with weed and fern growth as a result, not to mention the risks of increased erosion from the heavy storms. Can weed killers help us by being sprayed at quick growth times and so delaying growth until we can deal with them at the best time for us ? Pruning worries us a lot, we have been re-arranging our programmes, successfully I think, but is there a real need to go as light as some of us are ? Will not the time come very soon, when we shall have to give a low clean cut ? Are we prepared to face up to this ? Are we retaining that fine art of pruning as known to our earlier planters ? Is it advantageous to lengthen the cycle rather than reduce it as some are doing ? Do successive attacks of blister

remove from the bush as much as plucking does, and does the consequent delay in forming a big canopy and good wood warrant leaving the bush for a year longer before pruning, now that our plucking technique is so improved ? I think we need a lot of advice on this. Now I come to the real base : what of the "cures." I think we anticipate that these will be in two directions — the first in spraying, and the second by re-planting with resistant clones.

Will spraying wipe out anything else besides blister ? Brown blight for instance, which seems to exercise some check on sporing. Can we work out a programme of spraying that will protect our young fields through the initial seasonal attacks, and enable them to get well established ? Will this spraying allow us to yet harvest our flush for manufacture ? Most of us have been greatly encouraged by our experiments with spraying in the nurseries : but to a lesser extent in the field. Perhaps this is the fault of the equipment which was not designed for Ramasamy's heavy hand, and may I add, inquisitive mind. I think makers need to be reminded to supply their machines with an adequate stock of spares and directions, as we do not have machine shops round every corner. Again I hope a machine that can spray from our paths, and so save the heavy tramping of our soils will be evolved. Suffice to say that spraying for several rounds at foliating time, is a policy of economy over the cycle, and is repaid in leaf harvested, and tea bushes saved from decline. We do hope that simple advice will be given on when to spray and what the effects of heavy afternoon storms on sprayed tea is likely to be ; and whether ten day rounds should be irrespective of rain storms, or should a repeat performance follow a heavy shower ? What about prolonged monsoon periods, when blister is doing its worst ?

Re-planting with resistant clones is making good headway but it has been a period of trial and error for most of us. I feel that we tend to concentrate too much on blister resistance and pay insufficient regard to jat, yield, and quality. It will be a disaster if estates plant up with a poor yielding resistant clone, and which cannot produce a drinkable tea. Again, we are worried at the behaviour of seemingly resistant clones when transferred from one spot to another. Is there any fear of a resistant bush losing its resistance under varying conditions ?

Manufacture I do not propose to touch on, we all know the results of too much damaged leaf in our made teas and withers.

Those, gentlemen, are the main heads of our worries, I think, and I trust they will promote a free discussion this afternoon, but before closing, I wish to allude to two other points — There is a vague feeling amongst working planters that when it comes to trying out new ideas, the Scientist, plus an assistant, plus a K.P. plus a labourer concentrating on the job, has a much better chance of success than the somewhat harassed planter, chased by his agents and worried by his complacently obstructive labour force. I would ask the T. R. I. Officers to continue to bear with us if we don't manage things as efficiently as they do at first and promise them that we are triers — as to labour I know that Ramasamy and Meenatchi in the majority of cases are as worried as we are at the effects of blister. and I think a little more tactful propoganda in the Tamil and Sinhalese press might help our Labour to appreciate what I have tried to put forward as "The Planting Angle."

5. IMPRESSIONS OF THE BLISTER BLIGHT CONTROL PROBLEM.

(a) F. W. J. LANE (Plant Protection Ltd.)

My terms of reference were to consider and advise you upon the possibilities of large scale tea spraying. I arrived here on the 16th October and have had an opportunity of seeing a number of estates ; mainly to study terrain and conditions. Apart from this I have also carried out a number of small scale experiments in order that I could appreciate better the practical side of your difficulties.

In a matter of just over three weeks the most that can be achieved is a general impression of what is involved. I think I can say that I now have a reasonably clear picture of what is involved. On the other hand I can also say that I cannot offer you any ready made solution. I would have no difficulty at all in telling you what couldn't be done but Dr. Greenslade will deal with this point.

My own particular province is studying methods of spraying and from my various estate visits there is one thing that I can definitely state. There is no one method that is applicable to all conditions. These vary not only from estate to estate but also on individual estates. Hard and fast regulations cannot be laid down and much work will have to be done before any particular method can be decided upon for any one estate.

As far as I can see at the moment I would say that estates, or rather areas, can be divided from the point of view of spraying into three rough categories. Firstly, some areas where technically it would be possible to spray but on economic grounds it would be ruled out. Secondly, areas where the knapsack sprayer is now and probably always will be the only answer. Thirdly, some areas where subject to modifications in layout larger machines might be used.

I said earlier that my own particular province was the study of methods of application. Before I start work two things must be known. Firstly, the history of the disease and secondly a chemical that will, if properly applied, give an adequate control. This information has already been obtained by the Tea Research Institute. With this information two problems present themselves with regard to spraying. Firstly, with regard to tea recovering from pruning for which there is a suitable chemical for spray application. Secondly, there is tea in bearing which represents a very much larger acreage and for which no suitable chemical is yet available.

Mr. Loos has given you some brief details of his own experimental work. In addition to these I have carried out experiments on very much the same lines. My experiments were carried out with a battery charging plant and a set of eight pneumatic sprayers. The sprayers were modified by the addition of a small boom to enable two rows of tea to be sprayed in approximately the same time that one is now sprayed using a conventional machine. The booms were fitted with low volume nozzles which reduced the application rate of the spray to 13 gallons per acre. The amount of fungicide was 4 ounces to every 10 gallons of water. The central charge pump was mounted on a lorry to make it as mobile as possible. On what might be described as

average terrain four labourers sprayed five acres in 3¾ hours.

It is admitted that conditions especially with regard to supervision were probably much better than the average estate superintendent has either the time or staff to achieve. If, however, these figures are analysed a little further they will, I think, be found most interesting. On the basis of the acreage sprayed in 3¾ hours the total covered in an 8 hour day would have been 11 acres. Including one man for supervision, one to operate the central charge pump and drive the lorry and the four labourers the total staff amounted to six. Without loss of spraying time the spraying force could have been increased to six leaving only two spare knapsacks for refilling instead of four. With six labourers actually spraying with the same amount of supervision the output would have been 15 acres in 8 hours. This experiment is, of course, open to criticism inasmuch as output per labourer per hour would be less after the first four hours. There were no breakdown of equipment. Water supplies might not always be readily available. Weather conditions might be unfavourable. If, however, to cover these eventualities and varying conditions of terrain we were to reduce the acreage sprayed by 50 per cent the total is still 8 acres per day for a labour force of eight men. With acreage to be sprayed every seven days it might well be possible with a battery sprayer of this size to make eight men responsible for an area of some 45-48 acres.

Organisation of supplies is, as Mr. Ananda Rau has already said, a very large factor in completing the work. Good organisation not only in this case but in every other can make all the difference between success and failure.

I have given figures relating to one unit ; it is a simple arithmetical calculation to show how many such units would be required to spray 100 acres or 200 acres every seven days. As I have said before, small scale experiments are open to criticism, but I think that the evidence so far available gives ample ground for large scale experiments to find the best methods of organisation and supply.

Before leaving the subject of knapsack sprayers I would like to comment on Mr. Loos' figures relating to costs. To give a truer picture I think that cost of supervision and cost of depreciation of equipment must be added. I cannot give you figures for each of these three as the conditions vary considerably. However, the following information would be useful in calculating these :—

1. *Supervision.*—This is absolutely essential if you are to ensure that the work is properly done. With a properly deployed spraying team one supervisor should be adequate for every six labourers operating knapsacks.

2. *Depreciation.*—Three factors have to be considered. Firstly, standard of manufacture of the machine ; secondly, standard maintenance; and thirdly, the way in which it is handled. From what I have seen the last item is the most important. Some of the methods employed by labourers in handing the equipment leave much to be desired. It is difficult to lay down hard and fast rules but I would suggest that depreciation might be as high as 40-50 per cent

I have talked quite a lot about knapsack sprayers, but I am quite certain that many of you hold the view that using these small machines is not the answer to a big problem. Mr. Morford has asked whether a machine could not be produced that would spray from the estate paths. Such an equipment would, from the general conditions, appear to be the only type that could be used. A machine that would carry the spray from the pathway over a wide area

of crop would be ideal. Two such types of equipment are the fog machine and the mist blower. However, both these types have limitations. In fine weather with still air conditions it is quite possible to distribute the spray over a wide area. Unfortunately, during monsoon seasons the fine weather and still conditions are rarely found, with the result that the range of penetration of the spray is very much curtailed.

From what I have seen of monsoon conditions the range of penetration of the spray would probably be no more than 30-35 feet. I mentioned fog machines and mist blowers. There is a certain amount of confusion with regard to them. They operate on entirely different principles and I think that some definition might help to give a clearer picture.

A fog machine produces very small particles of spray by introducing the material to be atomised into a combustion chamber. The resultant fog is then dispersed from the equipment. A mist blower is a definite attempt to reduce the quantity of spray required by replacing some part of the liquid by air. In addition the air is used to provide the energy to carry the spray to the crop.

Of these two types of equipment I think that a modified form of mist blower might be found suitable for use on a number of estates which are already well provided with paths or on those where, with slight alterations in layout, paths could be provided.

With regard to the fog machine there is no record as far as I am aware of it ever having been used successfully for the application of a fungicide. Apart from this, wind conditions would, in my opinion make the machine entirely unsuitable for use as it would be quite impossible to control the movement of the fog.

Dr. Greenslade will, I think, have something to say about other types of equipment which might possibly be used. However, we are faced with the problem that under the weather conditions experienced during the monsoon, the effective range of not only the mist blower but other types of machines is likely to be only 30-35 feet which means paths should not be more than 60-70 feet apart. As I said before, on some estates it might, without modification or with very slight modification in layout, be possible to use them. The whole question is, however, one of economics and large scale experiments under a variety of conditions is the only way in which the suitability of any type of equipment can be decided.

(b) R. M. Greenslade (Pest Control Ltd.)

When Blister Blight first hit the Ceylon Tea Industry it naturally became the duty of the Tea Research Institute to do something about controlling the disease. I understand that since 1946 several members of the staff, Dr. Gadd and Mr. Loos in particular, have had to give their whole time to the problem with the result that they soon got to know the habits and behaviour of the fungus causing the disease. Without this fundamental information it is impossible to make intelligent attempts to control any disease. If one rushes in wildly with large scale spraying, without this knowledge, it is possible to spend a lot of money applying the wrong fungicide at the wrong time and getting nowhere. One example will demonstrate the practical value of this

detailed study. Mr. Loos mentioned that the blight spores nearly all germinate on the upper surface of young leaves. The fact that it is only necessary to spray the upper surface of the young leaves makes all the difference between a possible operation and a financially impossible one.

When dealing with a fungus disease one first thinks of spraying as a cure. But spraying is an added expense on the cost of production of tea and, as some people forget, a recurring expense. Spraying is to be avoided if the disease can be defeated by some alteration of agricultural practice. You have, therefore, tried the methods described by Mr. Portsmouth and in many cases these alterations in pruning and plucking methods give you adequate control of blister blight.

On other estates where Blister Blight is particularly bad, or where alteration of the pruning cycle causes too much dislocation of the normal routine, it is necessary to consider spraying. The tea industry has been very fortunate in not having to spray before now, but this very good fortune means that there is no background of spraying experience and knowledge in the industry. The Tea Research Institute, therefore, considered it advisable to invite Mr. Lane and myself to study the conditions here and make some suggestions, before they embark upon extensive tests of the available spraying machines.

The spraying of tea resolves itself into two problems, the choice of a suitable fungicide and the choice of a suitable means of application. The first problem is partly solved. For the protection of tea recovering from pruning copper sprays give adequate control. For tea in plucking, as Mr. Lamb has explained, copper sprays cannot be used owing to the risk of leaving too much copper in the made tea. Some non-metallic fungicide must be found. Mr. Loos has tried most of the available forms of non-metallic fungicides with only partial success, but so much research is going into this question that I think it very probable that a suitable compound will soon be found. Mr. Harrison has mentioned a systemic fungicide. This means a chemical which could be sprayed on the tea bush, and which would be absorbed by the old leaves and travel in the sap to the new leaves making them resistant to the fungus. This would be an ideal treatment since it would make it unnecessary to spray at such frequent intervals, and once the spray was absorbed into the leaf, no amount of rain could wash it off. I am particularly interested in this type of chemical since I have been associated with the development of systemic insecticides. and my firm's research department are testing materials which may be of use as systemic fungicides. Dr. Horsfall and his colleagues at the Connecticut State Experiment Station have shown that this form of fungicide is technically possible but it is not yet a commercial proposition. Possibly some such compound may be found suitable for Blister Blight but in the present state of our knowledge we cannot hope to adopt this method within the next two or three years.

The second part of the problem of spraying tea, the method of application, would be no problem at all if tea were grown on perfectly flat land. Spraying could be cheaply mechanised and blister blight very easily controlled. Given the existing growing conditions we must conconsider either spraying with knapsack machines or the development of special machinery for mechanised spraying Mr. Lane has dealt with knapsack sprayers : I need only say that I agree entirely with his conclusions that on many estates knapsack spraying is the only answer to blister blight As Mr. Lane and Mr. Ananda Rau have said, the cost of the operation can be quite

low if close attention is given to details of transport, mixing, water supply and training of labour and supervisors.

Since I have been in Ceylon I have noticed a certain amount of over optimism about what can be done by mechanical sprayers. This is perhaps natural when one's acquaintance with large spraying machinery consists of descriptions and photographs of machines doing jobs for which they were specially designed. As I have had some experience of using special machines on contract spraying where I have had to guarantee results, I have been able to learn some of the advantages and limitations of the various types, and it may be useful if I consider the main types in relation to tea spraying.

On seeing the broken nature of the tea country one thinks first of aircraft, particularly of helicopters, but these have the following disadvantages: the shade trees would keep the aircraft too high above the crop and would intercept far too much of the spray; the higher estates are above the altitude at which available helicopters could operate with a full load; most of the blight spraying needs to be done in the monsoon and no aircraft could be expected to fly into the higher valleys in the monsoon rain and wind; the worst areas of all are the mist belts where no aircraft could ever fly. Aircraft spraying must, therefore, be considered impossible for this purpose.

The next type is the fog machine in which a fine mist of insecticide is allowed to drift long distances in the wind. This is a most excellent way of controlling flies and mosquitoes, but I do not believe it has yet been successfully used to form a protective deposit on a crop, and in any case there is no control over the fog, and in monsoon conditions it would be almost impossible to ensure that it is not blown away.

A third type is the "mist blower." In this case the fine spray is assisted by an air blast. The airblast enables one to project the spray in the right direction and the droplets of spray being larger than fog particles will form a deposit on the crop. Some of these mist blowers have hundred horsepower engines and produce a wind blast of 190 miles per hour. This principle might well be adapted to tea spraying, but any such machine small enough to travel on the ordinary tea paths could not be relied upon to throw its spray more than 30 feet from the path. In still air this might be doubled but at the normal spraying times we cannot expect much still air.

The remaining type of sprayer is the ordinary type used for fruit tree spraying in which the spray is carried by hydraulic force alone without the assistance of air blasts. Spray can be applied at 10 gallons to 20 gallons per acre if coolies using hand spray lances walk down the rows pulling hoses behind them. On some estates this may be quite possible but on others the heavy hoses may do much damage to the bushes. Spray can also be applied by high pressure jets directed by a spray operator from the tea paths, but again the range will be limited to about 30 feet from the path and to get this range considerably more water will be needed to produce a jet which will not be carried away by the wind. This again may be a practical method on some estates. An extreme example of this type of spray would be something on the fire hose principle with which the range could be very considerably extended, probably enough to operate from the ordinary cart roads, but it would be almost impossible to supply such enormous volumes of water and the very dilute spray so applied would be easily washed off in the rain.

I have mentioned three possible types of machines, besides knapsacks, but as Mr. Lane has stressed, to use any of them would involve alteration to the layout of the estate so as to have 3 foot paths every 60

feet across the hill slopes. On many estates this would be no great alteration, on others it would be very expensive or even prohibitive in cost. Whether such expense is justified on any particular estate depends upon the amount of damage being done to the crop, *and to the bushes*, and can only be judged by the man on the spot.

I think, however, that there is a very strong case for large scale experiments, presumably by the Tea Research Institute, to test the effectiveness and cost of these various methods of treatment. If such an experiment could be carried out on a scale large enough to give a true picture of the costs, then individual planters and estate owners would be in a very much better position to estimate the cost of treatment on their own estates.

DISCUSSION.

Dr. Norris then declared the conference open for discussion.

Mr. Lamb stated that as Dr. Greenslade and Mr. Lane had been very sparing with details of their experiences, he would like to mention that Dr. Greenslade had been associated with the team of workers who had developed systemic insecticides while Mr. Lane had taken a very active part in the International Colorado Beetle Campaign in Europe.

Mr. Portsmouth apologised for taking up the time of the members but wished to comment on a few points raised in Mr. Morford's and Mr. Ananda Rau's addresses. Mr. Rau, in his address, had stated that as far as Ceylon was concerned, the danger of carbohydrate deficiency existed only on estates below an elevation of 3,500 feet. Mr. Portsmouth said that during the last week or so he had seen areas of tea well over 4,000 feet in elevation with no carbohydrate in the roots at all. His advice was that such areas must be rested before pruning. During the resting period protection by spraying and supplementary manuring might also be necessary.

Mr. Portsmouth then dwelt with the points raised by Mr. Morford, seriatim:—

(1) *Resting tea.*—Resting must of course be done at any time necessitated by the state of the bushes. This meant that bushes may have to be rested during a period of heavy blister blight attack. If such was the case then spray protection might definitely be desirable.

With regard to the period of rest, all he could say was that resting must be continued until such a time as a healthy cover of foliage had been restored. The bushes might then be brought back into plucking by cutting across at such a height as to leave a good undercover of foliage below the new plucking level.

(2) *Manuring.*—A brief reference to this subject had been made during the morning and he only wished to point out that there was no scientific basis for the idea that either wood or leaf growth could be stimulated separately by varying the fertiliser ingredients. Good wood growth was only one sign of a healthy growing bush to produce which, adequate applications of a properly balanced mixture were required.

The full benefits of resting might not be obtained if growth was limited by manurial shortage.

(3) *Shade.*—Nothing in Mr. Morford's paper suggested any need for departure from the well established T. R. I. policy of judicious control of shade. Shade and green manures were of inestimable value to the tea and should not be cut out unnecessarily. Judicious thinning should, of course, be carried out in those areas where early morning mists hung about so that the sun could get to the bushes and dry them out. These, however, seemed to be mainly transitional areas in which blister blight infection was never very heavy. In bad blister blight areas the fields were shrouded in cloud or rain for most of the South West monsoon so that the presence or absence of shade would have little effect except at the end of the bad weather period.

(4) *Weed-killers.*—There was no known weed killer available, which would not also damage tea.

(5) *Pruning.*—He was only too glad to note that the fine art of pruning as known to some of our earlier planters was disappearing. If the saw was used today to the same extent as it was in the past then he was afraid that we should say good-bye to most of our Up-country tea in a very few years.

Mr. W. H. Attfield (Bosanquet & Skrine) expressed great pleasure at the presence of a representative of the Ministry of Agriculture (in the person of Dr. Pieris) at this symposium, and hoped that he would convey information about the proceedings of the symposium to the Minister.

Mr. Attfield said the Industry would need a great deal of money for the control of blister blight, it had already been allowed a certain amount, but a great deal more would undoubtedly be needed. He suggested that the Government should be approached with a view to getting back the tax levied on estates under the Food Production (Estates) Ordinance.

Mr. Attfield then raised the question of co-operation and enquired whether legislation would be brought in, and blister blight declared a serious disease which all estates should control. If so, about 20 per cent of the estates in Ceylon were non-company owned and steps would have to be taken to ensure that those estates would also control the disease.

Then there was the important question of discipline on estates. Mr. Attfield had reason to believe that there was already a political move to see that discipline on estates, particularly on company-owned estates, was completely destroyed, and enquired what the Government of the country intended doing about this matter.

Mr. Thambipillai (Dickoya District) said that most of the previous speakers had dealt with spraying. However, he now suggested that some volatile substance which was also a fungicide should be given to all the pluckers, so that on their plucking rounds they could impregnate the whole area with this fungicide and thus kill the spores. Mr. Thambipillai said he was surprised that the scientists did not think of this method previously.

Mr. L. B. de Mel (Kelani Valley) enquired whether it would be possible to reduce the strength of the Perenox to such an extent that it could be applied to tea in plucking.

Dr. Norris replied that it might be possible, by improved methods of spraying, to keep spray residues within the limits of tolerance for copper.

Mr. Brodie (Morawak Korale) asked Mr. Portsmouth whether it would be advisable, in view of the threat from blister blight, to open up new clearings at elevations of about 2,000 to 4,000 feet above sea level with seedling plants.

Mr. Portsmouth replied that assuming the areas had no old tea in them (Mr. Brodie confirmed that this was the case) then they would be bound to use seed, but pointed out that if blister blight was prevalent in that area, it would be necessary to protect the new clearings by spraying up to a fairly late stage of their growth.

Replying to a further query by Mr. Attfield with regard to the resistance of seed bearers grown from resistant clones. Mr. Portsmouth stated that, scientifically, there was no reason to suppose that anything, except a very small proportion of seedling progeny would be resistant. It really depended on the factors involved in resistance and he had no information to offer on this. All he could say was that only a very small proportion of the progeny could be expected to show resistant characteristics.

Mr. D. S. Sutherland (Dimbula) enquired whether it was possible for a bush to develop resistance to blister blight after repeated attacks.

Dr. Norris replied that there was no evidence of disease resistance developing in any other plant. The mechanism of disease resistance in plants was very different to that in animals, and it was most unlikely that a tea bush would develop resistance after repeated attacks of blister blight.

Mr. Bolster (Uva) wished to know whether the Institute had rejected any idea of controlling the disease by improving or correcting the nutrition of the bush. According to Mr. Harrison, blister blight was prevalent in North India from the end of the 19th Century, but it was only in the last few years that it had become a serious problem. Mr. Bolster enquired whether this could be attributed to nutritional factors.

Mr. Portsmouth said he had all along tried to emphasise that nutrition was very definitely a most important factor in dealing with any disease. It might not necessarily be that infection would be any less on healthy bushes, but the effect of such infection would be very much less on healthy bushes than would be the case on unhealthy bushes.

Mr. Mayne said that they had recently started manurial programmes and that there were a number of estates where some of the fields had been manured and others not. His experience was that there was a lower percentage of infection, as estimated by a flush count, in the manured fields than in the unmanured fields. It was noticeable that tea in manured fields grew very much faster.

Mr. Harrison said that as far as North East India was concerned, the disease was first found in Upper Assam and had remained there for a matter of 80 years. This area had always been the best fertilised, and from this fact, it would seem that blister blight seemed to have followed increased nutrition.

Dr. Norris pointed out that there were plots on St. Coombs Estate which had received full manurial applications and others which had not received any manure. The results of various experiments had shown that there was no significant difference in the way the various manurial treatments had affected blister blight incidence. If anything, according to these experiments, it would seem that blister blight favoured the manured fields.

Mr. Lamb pointed out that the plots referred to by Dr. Norris included plots manured entirely with compost.

Mr. Morford enquired whether the pruning cycle should be shortened or lenghened. He felt that, when pruning was as light as it was at the time of speaking the cycle should be shortened. He wished to consider the economics of spraying very large areas of tea recovering from pruning in relation to the length of the pruning cycle.

He was of the opinion that estates running a three year or four year pruning cycle could afford to spend far more on spraying than they could if they pruned every two years.

Mr. Portsmouth replied that the length of the cycle would still be governed by economics. In other words, if it paid an estate to run a four year cycle instead of a three year cycle then that should be done. But if the crop of that estate was going to fall in the 4th year, then that estate must come back to the three year cycle, irrespective of whether it rested the tea or not. It was quite probable that in many fields, particularly those where a fairly long cycle was adopted, the continuing attacks of blister might so defoliate the bushes and upset the balance of crop, that the cycle might have to be shortened.

Ir. van Emden said he gathered that there was a certain degree of anxiety that blister blight might be due to Ceylon tea being too old and that the bushes had reached the end of their span of life. In this connection he pointed out that Sumatra's tea was only 20 years old and had been rested right through the war years, when production completely ceased. During that period some tea bushes had grown to the enormous height of 20 feet to 30 feet. After the war, tea production was started again, but in spite of this the blister blight situation in Sumatra today was far worse than in those areas of Ceylon which he had seen for himself.

Mr. van der Kiste (Dickoya) said that so far, discussion had been centred on the control of blister by means of spraying. He wished to know whether it was not possible to ascertain exactly what made certain bushes resistant to blister blight. He felt that if the Institute could find out exactly what made certain bushes resistant to blister blight, the particular character or substance might be developed. Mr. van der Kiste was of the opinion that the lines followed at present, viz. that of spraying, were only a very temporary palliative. What should be aimed at was the complete eradication of the disease, and this might be attained once the exact reason for certain bushes being immune or resistant to blister blight was discovered.

Mr. Ananda Rau explained that experiments were being carried out in South India in this connection, but up to date they had not been successful in discovering what made certain bushes resistant to the disease.

Mr. Portsmouth said that Mr. Loos had been very busy with full scale experiments with spraying equipment. This question would, however, be kept in the fore-front of the Institute's future programme and as soon as work on spraying experiments slackened, Mr. Loos would give the matter his attention.

Mr. Cameron (Dimbula) said that at the last conference, held in Kandy, the Chairman had asked if any one present at that conference could give him any figures for loss of crop due to blister blight. Nobody was brave enough to get up and answer that question, but one gentleman said that he could not give any estimate. Mr. Cameron was of the opinion that every planter present at this symposium would, in his own mind, have formed some estimate of the loss that can be attributed to blister blight on his own estate. He sought the opinion of the conference, especially that of the Tea Research Institute, as to whether the recurring attacks of blister blight had a progressively bad effect on the tea bush or whether recovery in the dry weather made the bush as good as a new one.

Dr. Norris replied that the general opinion was that repeated attacks of blister blight must have a harmful effect on the bush. As he had already stated in the morning, deterioration was already evident

on many tea estates but many factors were responsible for that state of affairs. Blister blight must not be made a scape goat.

Mr. Cameron wished to know whether loss of crop due to blister blight would progressively increase with time, and to this question Dr. Norris replied that developments depended entirely on what measures were taken against the disease. That was why resting had been advocated as one method of treatment. In addition, greater attention had to be paid to plucking, pruning, etc. As to how far these recommendations would succeed, especially in the mist belts, could not be predicted, but it was an approach to a possible solution.

Mr. Helling (Dimbula) stated that Mr. Lane had made some very disturbing remarks about rainfall when he had said that in areas having a rainfall of between 30 ins. to 50 ins. of rain per month, spraying would be out of the question. 30 ins. to 50 ins.of rain was quite normal under the monsoonal conditions in several districts in Ceylon, and if spraying could not be carried out during those periods, it would be difficult to carry out any spraying at all for purposes of gaining crop. Mr. Helling also referred to Mr. Harrison's remarks that leaf outgrows the spray and asked for information as to how this affected tea recovering from pruning, if such recovery took place during the season when blister blight was in force. Mr. Helling visualised that a certain number of buds and leaves would have been formed on the tea bush before the next spraying was done, and enquired now often that tea would have to be sprayed and, further, if the tea was recovering when the monsoon was at its peak whether it would be feasible to protect the young leaf to any worthwhile extent. Mr. Helling also enquired whether any experiments had been carried out to discover the effect of infra red and ultra violet rays on the tea bush, as a means of controlling blister blight.

Mr. Mayne pointed out that it was not entirely a question of the total rainfall, but a lot depended upon the form in which the rains came. Speaking of South India, he said that in the S. W. Monsoon in the peak period, when they had something like 100 ins. of rain, their number of dry periods was so small that any applications of fungicides would be washed off with very little chance of any deposit being left on the leaf. He had very little hope of successful spraying under conditions of that order.

With reference to Mr. Helling's query about the further growth of leaf after a spraying was carried out, Mr. Harrison said that was mainly the reason why spraying was carried out at close intervals of seven days or even shorter intervals. Fortunately, in N. India the period over which the blister ripens was only of a short duration If blister blight appeared they made one application of spray quickly, and continued spraying at weekly intervals until it was possible to tip.

With regard to Mr. Helling's query on the use of infra red and ultra violet rays, Mr. Lamb stated that it was extremely probable that the effect of sunlight on blister blight spores was mainly desiccation but even if it was possible in the laboratory to control growth by ultra violet or infra red rays, the cost of applying treatment in the field would be prohibitive.

Mr. Campbell (a visitor from London) said that they had heard rather depressing news from the two spraying experts, and enquired whether the Tea Research Institute had carried out any experiments with the application of heat to the disease, by the use of hot air. He understood that there were some machines available in America with which it was possible to apply hot air to certain diseases. He appreciated that it would be a very expensive method of control. Nevertheless, he asked the question to broaden the scope of the discussion.

Mr. Portsmouth said that, from the experience he had had in the use of various temperature chambers of the type referred to by Mr. Campbell, viz. Dry Chambers, he could assure Mr. Campbell that the cost would be fantastic.

Mr. Pelham Roberts (Dickoya) enquired whether it was the right policy to pluck hard on blister blight attacked teas. As things stood, he felt that blister blight hit the bush hard, estates in their turn hit it harder, and the plucker hit it harder still. He also enquired whether it was right to stop supplying until such time as estates had no further trouble with blister blight. He was of the opinion that if estates stopped supplying, in a few years' time many estates would have got nowhere in the control of blister blight, and then matters might turn out to be disastrous. Some estates, with the suggestions made by the Tea Research Institute, had been able to put out bushes that had got a certain amount of foliage and he therefore could see no reason why estates should stop supplying.

In reply to Mr. Pelham Roberts, Mr. Portsmouth said that he had tried, in the morning, to make it clear that there were two distinctions with regard to blister blight attacks. Firstly, when the blisters were confined to the leaf only, it was unnecessary to pluck hard. But, in the second stage, when blisters appeared on the stem, probably below the fish leaf, and the whole of the shoot became blackened and died off, no good was done to the bush by leaving the third leaf. Certainly no good was being done to shareholders by not plucking. What obviously must be done was to pluck hard during the period of such stem attack. Afterwards the bush had to be allowed to rest to compensate for loss of foliage leaf.

With regard to Mr. Roberts' second query, viz. supply, Mr. Portsmouth said everyone would be pleased to hear that a certain number of estates in bad areas were still successful with supplies from seed, and where this was being achieved, he saw no reason why it should be stopped. He emphasised, however, that the point he was trying to make in the morning was that, where the percentage of establishment was so small as to be almost negligible the actual cost of establishment in the field would probably, when worked out, prove to be quite prohibitive, although the actual cost of putting out each single plant might be very low. What should be considered was not the number put out, but the number successfully established in the fields two years later. If any planter could succeed in doing this, no matter whatever methods were adopted, then he (Mr. Portsmouth) himself would be all in favour of it.

Mr. Fay (Uva) said he believed that the practice in Darjeeling was to break back young shoots when bushes recovering from pruning were attacked by blister blight, and asked Mr. Harrison whether he could give the meeting any information on this point.

Mr. Harrison said he had no information to offer on this point.

Mr. Lamb stated that when he returned from his visit to North India, he had told Dr. Gadd about the practice mentioned by Mr. Fay. Dr. Gadd had carried out a few experiments on St. Coombs, but Mr. Lamb could not remember whether anything useful resulted from the experiments.

Dr. Norris pointed out that, up to this stage of the proceedings, almost no views at all had been offered from representatives of the Uva District, and asked those representatives present whether they had any points which they wished to ventilate.

Mr. Cathcart (Uva) stated that their district seemed to be fairly well blessed as far as blister blight was concerned, and that up to date estates in the Uva district had

not been troubled very much with this disease.

Mr. Francillon (Uva), however, could not agree with Mr. Cathcart. He said a considerable amount of blister was in evidence on some estates. They were, however, fortunate in that their estates had only one attack during the year, but when blister was in evidence in that district it became a really serious menace and resulted in a certain amount of loss of crop.

Dr. Norris said that quite a number of Superintendents present at the meeting had some experience with Vegetative Propagation work on their individual estates, and the Institute would be very interested to know what success had been achieved in finding resistant bushes. If such resistant bushes had been discovered, the Institute would like to know whether, on putting them into the field, those bushes had maintained their quality of resistance. Any information on this point would be of considerable interest to the Institute.

Mr. Francillon said that he had marked out 100 bushes in recently pruned fields for Vegetative Propagation. He had watched these bushes gradually develop blister until finally the number was reduced to only one bush, and even that one bush had about 15 blisters on it. He had taken cuttings from that bush and put them into the field. It was, however, too early to give any indication of the results. He was of the opinion that the best method was to take cuttings from recently pruned fields, as there was little value in cuttings taken from older areas.

Mr. Bolster (Uva) stated that he had taken 20 cuttings from a resistant mother bush and planted them out last year. 18 of these cuttings had developed blister, and only two had remained immune to the disease. In all, 8 cuttings had come through so far, although they were attacked by blister, but actually only two cuttings showed any real promise of resistance.

Mr. Prichard (Messrs. Harrison & Lister Engineering Ltd.) enquired whether Mr. Loos could give him any information as to the exact time and type of weather conditions particularly favourable for the bursting of the blister. He would, for instance, like to know whether bright sunshine after a long period of mist tended to make the blisters burst. His object was to try and find out, from the practical point of view, if these spores could be tackled while still in the air, as this would give a better chance of fighting the disease than after it had actually settled on the leaf.

Mr. Loos stated that no details were available on this point.

Mr. Lamb stated that it was most unlikely that there was any special time at which blisters were liberated. It was largely a matter of the fungus reaching a certain stage of maturity.

Mr. Laurie (Hewaheta) enquired whether in the case of pruned tea, the Institute would advise that the side branches, which had been left on for a considerable time should be left as they were, or whether they should be taken off after the 1st or 2nd round of tipping. He said that in one of his fields which was badly attacked by blister blight, the side branches were free from the disease but the central portions of the bushes were heavily attacked.

Mr. Portsmouth asked what the elevation of this particular area was, and Mr. Laurie replied that the field in question was at an elevation of between 3,500 to 4,000 feet, in a mist belt.

Mr. Portsmouth then said he considered that it would be dangerous to remove side branches in this particular case. If attacks of blister continued it was definitely a case for spraying.

Mr. Adams (Nuwara Eliya) said he wished to speak on behalf of an estate near Nuwara Eliya. The estate in question was at an elevation of about 5,000 feet and had about 1,000 acres of tea. The cure of the disease appeared to be worse than the disease itself. Such an estate must lose a good percentage of its crop due to blister blight. The percentage loss of crop was calculated to have risen from 3 per cent in 1947, to 13 per cent in 1948 and 20 per cent in 1949. The yield was undoubtedly more, but given a yield of 500 lbs. per acre for 1,000 acres=500,000 lbs., deduct 1/5 or 20 per cent and the loss was 100,000 lbs. Estates such as this could afford to spend a good deal if only to reduce the loss by half. On this estate, pruning was possible only during one time of the year, and by pruning at this time of the year recovery took place into fine weather, and this period was usually the time for the main crop. Thus, during the crop season, a good percentage of the estate was pruned down. In the first year, at the time of the normal crop, 1/3rd of the estate was pruned, in other words, 1/3rd of the estate's crop was lost that year. In the 2nd year, 2/3rds of the estate was not in full production at the normal crop period, and last year very nearly 3/3rds of the estate was not in full production at the time of normal crop, which must account for the big loss of crop. Mr. Adams pointed out that, unless spraying could be carried out during the wet weather, and pruning done as in the pre-blister days many estates must lose crop due to being pruned at the wrong time of year for crop, but at the safest for blister. He enquired whether the scientists could produce a spray which would assist or ensure recovery from pruning during wet weather so that pruning could be done as before.

In reply to Mr. Adams, Dr. Greenslade stated it would certainly be useless spraying if that spray was to be washed off the bushes immediately after application He pointed out that he had not been in Ceylon long enough to have experienced the full monsoon periods and as such did not possess a complete knowledge of monsoon conditions. But from the short period of his stay in Ceylon, he had seen and experienced enough of general conditions to form a general picture of the situation. Most sprays had to be given at least half an hour to allow them to dry on the bushes, so that they would not be washed off. If it rained within half an hour after spraying, most of that spray would be washed away, and such spraying could never be beneficial to the bushes. For effective spraying, there should be a certainty of reasonable conditions for at least half an hour after the spraying operations. As far as he could see, spraying could never be effectively carried out under continuously wet conditions.

Mr. Lamb stated that Mr. Loos had carried out experiments on St. Coombs to find out whether spraying tea during monsoon periods was feasible. These experiments had been carried out during the last S. W. Monsoon and Mr. Loos had obtained some promising results. Mr. Lamb then raised the question of rainfall distribution. If the estate Mr. Adams referred to had the light, misty type of rain during the S. W. Monsoon, then conditions on that estate would be very similar to those on St. Coombs. During the growing season there were usually some fine periods, sufficient to allow sprays to dry. In continuously wet periods with heavy rain the disease appeared to subside naturally.

Mr. Morford enquired whether there was any information as to the best time to spray, whether spraying should be carried out during bud break into wet weather or tipping into wet weather. He was interested to know which of the above two methods would produce better results.

Mr. Portsmouth replied that the answer to that question had not been found at the

moment. The main point, of course, was that if blister infection was about, then spraying must be started before one got actual signs of bud break. The spray has got to get on to the bush first, i.e., before the spore reaches it.

Dr. Dike (Metalo-Chemical Refining Co.) said he had spent a few weeks in America and has seen many spraying machines in that country. He agreed entirely with Mr. Lane and Dr. Greenslade that the most difficult problem at the moment is to find apparatus which would be suitable for use under conditions prevalent on Ceylon Tea Estates. In America everybody was convinced that the development of good machines had only just begun. Dr. Dike said he had some experience with aeroplane dusting and agreed with Mr. Lane that Helicopter spraying would not be beneficial on Ceylon tea areas. At the moment, however, new types of Helicopters were being evolved in America which are much cheaper and which might be very useful in the future. It would, however, be problematical whether even this new type of Helicopter would be suitable for spraying Ceylon tea areas. He was convinced that at the moment, the only type of machine which could be used with any likelihood of certain results was the knapsack. He informed the conference that in Holland and England they were at present evolving a new type of sprayer, a mist-blower, which had a range of about 120 feet. When this apparatus became available, Dr. Dike felt that it might be a solution to the control of blister blight.

Mr. Groves (Dickoya) asked for information about the weight of the knapsack sprayer, and said that the weight of the equipment was a very important factor to consider.

Mr. Lane replied that the weight of the knapsack sprayer varied according to the size of the machine and its make. The knapsack used in his experiments at St. Coombs carried 2¾ gallons of water and had a total weight of 50 lbs. The machine could of course be lightened by carrying a smaller quantity of spray fluid. There were other smaller types of light-weight knapsack sprayers, varying from 25 to 30 lbs. in weight. Of course, no hard and fast rule could be laid down as to weight and different types might be required for varying conditions.

Mr. R. J. S. Bean (Kelani Valley) said that as Blister Blight was a leaf disease, it should be possible to control the disease by controlling the amount of susceptible leaf. He asked Mr. Portsmouth whether it would be possible to eradicate the disease by completely isolating a district in pruning, so that it would in effect mean complete defoliation of an area for a period of 2 or 3 months.

Mr. Portsmouth replied that it would all depend on what complete isolation meant. Theoretically, that is if isolation was complete, there was every reason to believe that eradication of the disease would be possible. Unfortunately, however, it was unlikely that complete isolation was attainable. Previous to 1949, Sumatra and Java were rejoicing in the idea of their isolation from Ceylon, but at this time, from what was said during the morning by representatives from that area, the disease was affecting Sumatra to a worse degree than Ceylon.

SUMMING UP BY THE CHAIRMAN OF THE BOARD OF THE TEA RESEARCH INSTITUTE— MR. R. C. SCOTT, C.B.E.

Mr. Scott, in his opening remarks, said he was proud to have been asked to try and sum up the proceedings of this symposium. He regretted that the Minister of Agriculture had not found it possible to be present, but expressed his pleasure at the presence of Dr. Pieris from the Department of Agriculture and hoped that Dr. Pieris would pass on information about the day's proceedings to the Minister.

Mr. Scott announced that the proceedings of the symposium would be published in an issue of the Tea Quarterly.

Continuing, Mr. Scott said that Dr. Norris, in his opening remarks, had referred to the fact that this symposium was of an international nature with expert opinion available at the highest level. He expressed great pleasure that such was the case, and that representatives from North and South India and from Sumatra were present to assist in trying to discover how best to treat this foul disease of *Exobasidium vexans*. Mr. Scott then alluded to the visit of Mr. Lamb to England during which time Mr. Scott himself was home on leave. It was very fortunate that Mr. Lamb was able to visit the U. K. because he was able to make personal and direct contact with Pest Control and Plant Protection Ltd. and convince them, by the evidence that the Tea Research Institute had accumulated in respect of the disease, that it was a very serious menace and one which demanded the best possible method of protection that was available. Mr. Lamb's efforts proved successful in convincing these two firms of the gravity of the threat to the Tea Industry in Ceylon. As a result of this mission, Mr. Lane and Dr. Greenslade had come out to Ceylon to give the Tea Industry their expert opinion on the practical aspects of the possibility of combating this disease. The main weapon of defence that appeared to be available to the Industry, was the fungicidal spray and Mr. Scott expressed the fervant hope that Dr. Greenslade and Mr. Lane would be able, before they left Ceylon, to recommend to the Industry a suitable method for applying fungicides to tea despite the difficult conditions of climate and terrain under which it was grown. Mr. Scott had seen various pieces of apparatus in the Institute's laboratory with which Mr. Lane was experimenting, and was very much impressed with the efforts Mr. Lane was making.

With regard to the Knapsack Sprayer, Mr. Scott said he believed that Mr. Lane seemed to think that this is the best weapon of defence available at the time. Mr. Scott expressed the hope that Mr. Lane would be able to modify this apparatus so as to allow for four rows of tea to be sprayed simultaneously. If Mr. Lane was successful in this, and Dr. Greenslade was able to provide a fungicide which was perhaps of greater effect than those which had been used up to date, then estates would be in a position to do much to protect their tea and the Tea Industry would be greatly indebted to those two gentlemen. If they could provide estates with such a solution, they would not only be assisting the Industry a very great deal indeed towards combatting this

disease of blister blight, but, looking at it from a most hopeful view, estates would be able to go back to pre-blister blight pruning and manuring programmes. If estates were able to go back to these former programmes, a great deal would be achieved, and the Industry would be most grateful to Mr. Lane and Dr. Greenslade.

Mr. Scott said that during the discussion one speaker raised the matter of spraying tea during dry weather to limit the carry over of the disease. The point was also mentioned that on many estates affected by the disease it was found that blister blight attack was restricted to certain areas, and Mr. Scott said it would be most beneficial if the Institute could follow up the idea and so delay the build up of the attack in the wet season. Mr. van der Kiste raised a very important point in connection with the factors that make certain bushes resistant to the disease. Mr. Scott expressed the sincere hope that the Institute would be able to solve this most difficult problem in the not too distant future, and thus succeed in finding a suitable fungicide which would be absorbed into the bush itself and make it more resistant to blister blight.

Referring to Mr. Harrison's and Ir. van Emden's remarks, Mr. Scott stated he had been shocked to hear that although a plant today appeared to be entirely resistant to the disease, there was no certainty at all of that plant maintaining its resistant characteristic after a short period of time.

He also expressed disappointment at the response made to Dr. Norris' appeal to gentlemen who had interested themselves in Vegetative Propagation, to say whether their internodes were subject to blister blight or not. He, himself, had 7 or 8 clones on his estate which appeared to be partially resistant, they were not entirely resistant but he hoped that they would remain very resistant. He felt disturbed, after hearing what Mr. Harrison and Ir. van Emden had just said, that it was quite possible that these plants might lose their resistance to the disease after some time.

Mr. Scott stressed the fact that the real remedy for blister blight would be the replanting of tea in Ceylon by gradual stages. A great number of tea estates in Ceylon would do well to replant and whether or not this vegetative idea of planting was going to be a failure, Mr. Scott was of the opinion that it would be advantageous to very many estates to undertake a programme of replanting in slow stages.

With regard to Mr. Newton's paper, Mr. Scott said that Mr. Newton had given comparative export figures for Ceylon in respect to tea, and had attributed the increase in the quantity exported in some measure to the fact that more manure was now available to estates. Mr. Scott entirely disagreed with this view, and pointed out that until this year, estates were using rationed manure — in fact, it was not until after April last, at which time he left Ceylon on leave, that manure became available to any great extent. Mr. Scott reiterated that Mr. Newton's remarks would not hold water, so far as the application of manure was concerned.

Continuing, Mr. Scott said he felt certain that this symposium had been of enormous interest to everyone present. Speaking, not as Chairman of the Board, but on behalf of the Planters of Ceylon, he expressed sincere appreciation to all the gentlemen who had come from other countries to attend this symposium. He assured these visitors that what they had told the conference had been of very great interest and personally he felt convinced that Ceylon planters after hearing them today, had a better knowledge of what was happening in

North India, South India and Sumatra, than they had before the symposium. He hoped that these gentlemen had enjoyed their short stay in Ceylon and considered it worthwhile coming all the way to attend the conference.

Referring to Mr. Harrison's suggestion that a symposium should be held annually, Mr. Scott said that personally he though annually would be too often for such meetings, but suggested that a symposium might be held biennially, the next in Tocklai, and two years after that in Sumatra or Java. He also expressed the wish that the time would not be too distant when all information on blister blight would be available, so that there would not be any necessity for any further symposia.

Mr. Scott thanked all the other gentlemen from Ceylon for their attendance at the symposium, and said he felt sure it had been of immense value to them as it had to him.

Once again, he thanked all the visitors from abroad, and others, for their presence, and especially Dr. Greenslade and Mr. Lane for their valuable advice.

The Symposium then closed, and members were informed that after an interval of approximately half an hour, an exhibition of films on the subject of pest and disease control would take place in the meeting hall.

A REPORT

ON

BLISTER BLIGHT DISEASE IN CEYLON TEA PLANTATIONS.

I. THE HISTORY OF THE DISEASE.

II. A REVIEW OF ITS EFFECT ON THE TEA INDUSTRY.

III. THE WORK OF THE TEA RESEARCH INSTITUTE.

IV. RECOMMENDATIONS FOR FUTURE RESEARCH WORK ON METHODS FOR CONTROLLING BLISTER BLIGHT.

(Submitted to the Tea Controller on 28th November, 1949, in connection with the provision of special funds for Blister Blight control work).

I.

THE HISTORY OF THE DISEASE.

The first record of the disease came from Assam in 1868 when Peal described the manifestations and stated that the disease had been present in that district for some ten years.

Thirty years later, specimens of tea leaves attacked by Blister Blight were sent by Watt and Mann, two Scientific Advisory Officers working for the Indian Tea Association in Assam, to Massee, the renowned Mycologist at Kew, who identified the causative fungus as *Exobasidium vexans*.

The first severe epidemic of the disease was reported from Assam in 1895 and 1900. In 1908 the disease spread to the Darjeeling district where the situation caused grave concern about the future prospects of the tea plantations in that area.

Comparatively little attention was attracted to the disease after the Darjeeling epidemic abated, until it appeared in South India in 1946. It is of interest to record that *Exobasidium vexans* was reported from Formosa in 1912, that it was noticed on tea bushes in the Botanic Gardens of Paiva in Italy in 1925 and again reported in Indo-China in 1930.

The present epidemic, which is causing alarm in all tea producing countries of the world, started in South India in September, 1946. The disease swept like wild fire throughout South India and the spores of the fungus, which are liberated in countless millions, were doubtless carried by the prevailing winds to Ceylon. Thus Dolosbage was the first Ceylon tea growing district known to be infected. The first specimen of tea leaves attacked by Blister Blight were received at the Tea Research Institute in October 1946. The disease spread across the tea growing districts of Ceylon from West to East and the rapidity of its spread is shewn by the following time table abstracted from the records of the Tea Research Institute which were compiled as diseased specimens came in by every post :—

Dolosbage	...	Oct., 1946.
Pussellawa	...	7th Nov. 1946.
Matale	...	12th „
Madulkelle	...	14th „
Ramboda	...	15th „
Dimbula	...	18th „
Dickoya	...	20th „
Kotmale	...	26th „
Rangalla	...	4th Dec., 1946.
Gampola	...	4th „
Maskeliya	...	4th „
Dehiowita	...	18th „
Hewaheta	...	21st „
Haputale	...	6th Jan., 1947.
Badulla	...	8th „

By the end of January, 1947, the disease had to all intents and purposes, spread over all the tea areas in Ceylon.

Blister Blight continues its advance and was reported from Sumatra in April 1949, where again it spread like wild fire over the 25,000 acres of tea in that Island. It seems almost inevitable that the disease will will spread to Java and Malaya.

Strict plant quarantine measures may prevent the spread of the disease to East Africa and place East African growers at an even greater advantage in future competition.

Little is to be gained by enquiring into the cause of the sudden spread of the disease but for the sake of completeness, it may be said that there is one theory which fits all the known facts and is that the barrier of distance and climate between North and South India was breached by transport of the disease on clonal material. Once the disease became established in South India movement of spores in cloud formation is compatible with our present knowledge.

There is some evidence that attacks by the fungus *Exobasidium vexans* may vary in virulence according to strains or types. The possibility of a particularly virulent strain having become predominant is causing some anxiety in Assam according to Mr. C. J. Harrison of the Indian Tea Association Research Station at Tocklai. Speaking at the symposium on Blister Blight Control held at the Grand Hotel Nuwara Eliya in Ceylon on 10th November, 1949. Mr. Harrison said that the disease had recently become more troublesome in the Assam Valley where climatic conditions have checked the disease previously.

Other theories of the cause of the present epidemic involving aircraft, clothing of travellers, etc. do not fit the known facts and must be rejected.

II.

A REVIEW OF ITS EFFECT ON THE TEA INDUSTRY IN CEYLON.

Blister Blight is undoubtedly the most serious disease which has ever threatened the Tea Industry in Ceylon. Mr. G. K. Newton, in putting the Agency House views before our symposium at Nuwara Eliya on the 10th November last, gave the following estimate of the losses that are being incurred as a direct consequence of the disease :—

> "For what is known as the Mid-Country Zone (2,000 to 3,999 feet) the intensity of attacks seems to vary very greatly according to the situation of the fields, but there is a general feeling that crop losses in these areas have now become serious amounting to between 5 per cent and 10 per cent. For the Up-Country Zone (4,000 feet to our highest tea a little over 6,000 feet) the losses appear to be even greater, in this case estimated at between 5 per cent and 20 per cent, according to the situation of the fields."

On the basis of Mr. Newton's estimates, it would seem that an overall loss of some 10 per cent must be accepted as the probable minimum for the whole of the Mid and Up-country tea areas. These areas combined produce more than half of Ceylon's total crop so that it is not unreasonable to assume that Blister Blight alone is responsible for a loss of rather more than 5 per cent of our total tea production. As the Customs returns for tea exported in 1948 were 296,000,174 lb. a 5 per cent loss of crop represents almost 15,000,000 lb. for this year alone. Furthermore, as most of this tea would have been High Grown it would have been expected to sell at well over the average price.

The Colombo Brokers' Association Weekly Tea Market Report No. 137 for the week commencing 14th November, 1949, quotes the following average prices as having been obtained :—

High Grown Teas	...	Rs. 3.16 per lb.
Medium Grown Teas	...	„ 2.72 per lb.

On the assumption that these price levels will be maintained and putting the average value of the tea lost through Blister Blight at a round figure of Rs. 3.00 per lb. it would appear that Blister Blight is at present causing a loss to the national economy of the order of some Rs. 45,000,000 per annum. Even calculated on the basis of the 1949 contract price the loss amounts to approximately Rs. 27,000,000.

Figures supplied by the Tea Controller give the acreages under tea in the various elevation categories to be as under :—

		Acres.	Acres.
High Grown	...	121,000	
Medium Grown	...	221,000	
			342,000
Low Grown	...	138,000	
Unclassified	...	63,000	
			201,000

On the above basis it will be seen that the High and Medium Grown teas constitute a good deal more than half of the total acreage under tea. In spite of this, however, the above estimate that approximately half the total crop is affected by Blister Blight should be allowed to stand since —

(a) The levels of yields are generally somewhat higher in the Low-Country.

(b) Infection is rather less in those areas such as the Uva District, which only have heavy rainfall during the North East Monsoon period.

In addition to the general Agency House views presented by Mr. Newton, individual Agency Houses have been approached by us and asked to furnish confidential information as to how Blister Blight is affecting their various properties. Although returns are still very incomplete, we have had replies to-date from some 12 Agencies giving particulars of some 38 different estates which are seriously affected by Blister Blight. A portion of one of these replies may be quoted as illustrating the type of attack now being experienced :—

"Blister has been bad throughout the estate this year but in particular in No. 1 field situated on a plateau at about 4,800 feet. This field was pruned between the 1st and 19th November, 1948, and was attacked on recovery in January. The field never really came into full plucking before the monsoon broke again, when it again contracted Blister Blight so badly that it had to be thrown out of plucking. It is still in a very bad condition and has shed nearly all its leaf. Below is a record of its yield per acre month by month since last pruning :

January	...	7 lb.
February	...	18 „
March	...	8 „
April	...	53 „
May	...	50 „
June	...	30 „
July	...	2 „
August	...	—
September	...	—
(Total to-date	...	168 lb.)

It was formerly a very high yielding field. Yield for the year 1946 July to 1947 June was 821 lb. and 1947 July to 1948 June was 656 lb.

No. 2 field situated on the same plateau pruned in November 1947 has also been badly attacked and is at present out of plucking. Its average monthly yield per acre since last pruning is 27 lb. per acre per month.

Another field, No. 12, situated at about 3,500 feet and having a stream running through part of the field, has also been badly affected ever since last pruning (28th October to 12th November, 1948.)"

This section will not be complete without one further quotation from Mr. Newton's memorandum as follows :—

"Although it is generally admitted that losses of crop are taking place, the Customs returns of the tea exported for the past five years are as follows :—

1944	...	273,453,894 lb.
1945	...	230,042,976 lb.
1946	...	290,511,908 lb.
1947	...	287,259,020 lb.
1948	...	296,000,174 lb.

which figures appear to contradict the general assumption, but I think to some extent the high total output since Blister Blight arrived has been occasioned by increased manuring on Low-Country estates following the greater

availability of artificial fertilisers after the war, and resultant high yields from those properties not affected by the Blight ; a higher intensity of plucking on properties which have recently changed hands, and also increased yields from the Uva Province, where weather conditions have been conducive of good flushes and where manure applications have also been increased."

III.

THE WORK OF THE TEA RESEARCH INSTITUTE.

Counter measures to plant or any disease develop in three stages :—

Stage 1. The investigation of the exact nature and course of the disease.

Stage 2. Reconnaissance of all possible protective measures based on the knowledge gained in Stage 1.

Stage 3. The trial of selected protective measures with adequate provision for testing efficiency and cost.

STAGE I.

The first stage of the research on counter measures has been completed by the Tea Research Institute. The information about *Exobasidium vexans* published before 1946 proved unreliable and a comprehensive mycological investigation more detailed than anything hitherto attempted was started late in 1946 and completed early in 1949.

This work is accepted as scientific work of the highest standard and is published in the "Transactions of the British Mycological Society."

Gadd, C. H. & Loos, C. A. The basidiospores of *Exobasidium vexans*. Transactions of the British Mycological Society, Vol. 31, pts. 3 and 4, pp. 229-233, 1948.

Gadd, C. H. & Loos, C. A. Further observations on the spore growth of *Exobasidium vexans*. Transactions of the British Mycological Society. (In press).

The main conclusions may be summarised as follows :—

1. The disease is transmitted by spores. These spores are destroyed by a few minutes exposure to direct sunlight but can live for a week in an atmosphere at 90 per cent relative humidity. Spores are about the same size as the particles which are visible in sunbeams.

2. The spores alight mainly on the upper surface of leaves. Infection of undersurfaces is relatively small, which simplifies spraying problems.

3. Under special conditions of humidity and free moisture, e.g. Dew, the spores germinate in 6 to 24 hours. On germination a mucilage is exuded which anchors the spore to the leaf and enables it to force a germ tube through the cuticle into the leaf tissue.

UP TO THIS STAGE THE DISEASE CAN BE CONTROLLED BY SPRAYING

4. The germ tube is only able to penetrate leaves or stems up to 30 days old. Very occasionally it gains entry to an older leaf.

5. After the entry of the germ tube the fungus grows rapidly and causes translucent, i.e. semi-transparent, spots to appear in the leaf in 6-10 days. The fungus flowers and seeds, i.e. sporulates, in 18-21 days. The blister may therefore appear on leaves which are 30 plus 18 days old and gives the false

impression that old leaves are being attacked. The spores are ejected with considerable force and are wind-borne.

AFTER THE GERM TUBE HAS GAINED ENTRY INTO A LEAF OR A STEM (or buds) SPRAYING IS INEFFECTIVE

Systemic fungicides may later be found which are effective at this stage. The selection of resistant strains of tea must also be mentioned as a major method of control.

6. There is NO RESTING STAGE OF THE SPORE which enables it to survive for long periods under adverse conditions. There is NO ALTERNATIVE HOST (at present) which will harbour the disease.

Drought and sunshine, therefore, give a large measure of control, and after a long drought it takes a considerable time for the level of infection to build up. The disease carries over through drought periods on new growth inside bushes or in damp shady situations.

7. The fungus is highly susceptible to copper-based fungicides but these leave a residue which rules out their use on tea in bearing. The search for fungicides which do not leave objectionable residues (or cause taints) is being actively pursued.

STAGE II.

Small scale field experiments to test possible approaches have already made considerable progress. Thus it has been possible to adapt modern low volume spraying techniques to our needs and to cover an acre of tea with as little as ten gallons of spray fluid. Former spraying technique used as much as sixty gallons of fluid per acre.

However, many other crops have to be sprayed as a routine measure against pests and diseases and there is a large fund of information on this subject available in Europe and America.

In order to draw on this fund of knowledge, Mr. J. Lamb, Deputy Director of the Tea Research Institute, flew to the United Kingdom in August 1949. As a result of this visit, Mr. F. W. J. Lane of Messrs. Plant Protection, Ltd., who has extensive experience derived from the International Colorado Beetle Campaign in Europe, and Dr. R. M. Greenslade who has many years experience of crop protection, including the last five years spent with Messrs. Pest Control Ltd. (who undertake crop protection work on a contract basis) flew out to Ceylon in October.

Advantage was taken of their presence in Ceylon to convene a Conference of Scientific officers from all tea producing countries affected by the present epidemic of Blister Blight and at the Symposium on Blister Blight control held in Nuwara Eliya on 10th November there were present :—

The Scientific Staff of the Tea Research Institute of Ceylon.

Dr. R. M. Greenslade of Pest Control Ltd.

Mr. F. W. J. Lane of Plant Protection Ltd.

Two Officers from the United Planters' Association of Southern India.

One Officer from North India — Indian Tea Association Research Station at Tocklai, Assam.

One Officer from the West Java Experimental Station, Buitenzorg.

One Officer from the Institute of Plant Diseases and Pests, Buitenzorg.

A Dr. Dike also flew from Holland to attend the Conference.

Dr. T. Swarbrick for many years on the Staff of the Long Ashton Research Station

and now Director of Agricultural Development work carried out by the Shell Company flew out immediately after the symposium.

Mr. Lane, Dr. Greenslade and Dr. Swarbrick all represent commercial interests, but crop protection is an economic problem and development and application of crop protection methods must largely depend on commercial enterprise. The final test of any crop protection method is the benefit accruing from its employment and this has to be determined in the field.

Stage 2 may now be regarded as almost complete. Mr. Lane and Dr. Greenslade have not submitted their final reports but the substance of their recommendations has emerged from a series of Conferences, in some of which Dr. Swarbrick was able to participate. Although these three gentlemen may be regarded as commercial rivals there is complete agreement amongst them on the major issues. Their views may be summarised as follows :—

1. That, results of the experiments carried out by the Tea Research Institute indicate that Blister Blight would normally be easily controlled by spraying methods, thinking in terms of other crops with which they have extensive experience.

2. That, at least for tea recovering from pruning, at which stage the bush is most susceptible to attack by the fungus, there are highly effective protective fungicides already available. Control has been demonstrated by the Tea Research Institute with as little as 4 oz. of "Perenox" per acre costing only 55 cents. It is generally agreed that proprietary fungicides should be tested against this standard.

3. That, the problem of application of the fungicides to the bushes constitutes the most difficult problem the advisory experts have been faced with.

   The difficulties of terrain could be overcome by the use of aircraft especially helicopters but this approach is ruled out by the high elevation above sea level at which tea is grown. Many estates are above the ceiling of such aircraft. Fixed wing aircraft could be used but the absence of landing grounds. monsoonal conditions including high wind and mist and the presence of high shade trees rule out approach from the air.

   Large power driven machines are ruled out unless extensive road systems are built.

   Knapsack spraying is possible provided that labourers can be trained to the work conscientiously and that supply systems can be organised to save time in re-filling.

   Small motor driven spraying machines may also be modified to meet the needs of some tea areas. Generally speaking. the problem is mainly a mechanical one and consists of adapting existing machinery to our special needs and developing new types of machines to reduce labour costs.

4. That, large scale experiments should be carried out as soon as possible to gain experience of difficulties, and also to check the successful results achieved in small scale experiments.

IV.

RECOMMENDATIONS FOR FUTURE RESEARCH WORK ON METHODS OF CONTROLLING BLISTER BLIGHT.

In the preceding section two main requirements emerged.

1. Provision of facilities for mechanical work in connection with development of spraying and dusting machines.

2. Provision for large scale field experiments.

The Tea Research Institute is now faced with a problem which has confronted most other agricultural research institutes having to carry out research work on crop protection methods. The Tea Industry of Ceylon has been exceedingly fortunate in enjoying almost complete freedom from major pests and diseases until Blister Blight arrived. Tea Tortrix, which threatened trouble at one period, was fortunately eliminated by a parasite bred and liberated from the Tea Research Institute. The Agricultural and Horticultural Research Stations at Rothamsted, East Malling and Long Ashton have met their requirements under such circumstances by establishment of Crop Protection Sections.

I, therefore, recommend the establishment of a Crop Protection Section of the Tea Research Institute with facilities and staff sufficient to deal with the research tasks set out above. In the first case we must budget for a four-year period after which the whole matter should be reconsidered. The Engineering part of the section could, with advantage, be absorbed by the Factory Experiments and Estate sections of the Institute. It is hoped that large scale crop protection experiments will not be necessary for a period longer than 4 years.

There are two methods of estimating for the expenditure involved.

1. Calculations based on the cost of running existing departments. The Agricultural and Plant Physiological Sections have for a number of years had considerable areas under field experiments. The Factory Experiment Section has been involved in much mechanical work. The average should, therefore, give a very fair estimate.

AVERAGE COST OF RUNNING ONE DEPARTMENT.

Summary compiled from Current Estimates

	Total for 5 Departments. Rs.	Average per Department. Rs.
Head of Department (Senior Staff) ...	90,760	18,152
Junior Scientific Staff	74,021	14,804
Sub : Scientific Staff ...	8,570	1,714
Laboratory Equipment	10,000	2,000
Dearness Allowance ...	50,032	10,006
Providend Fund ...	24,205	4,841
Field and Factory Experiments ...	17,500	3,500
Small Holdings ...	37,000	7,400
	312,088	62,417
General Administration and Upkeep ...	216,815	43,363
Depreciation ...	20,000	4,000
Low-Country Sub-Station	10,000	2,000
Capital ...	180,000	36,000
Rs.	738,903	147,780

On this basis, therefore, the average cost of running a Crop Protection Section for a period of 4 years should approximate to Rs. 150,000 per annum.

The first year will involve heavy expenditure and a factual estimate must therefore be made to cover it.

2. Estimates based on anticipated cost of work to be planned for the first year. These have been very difficult to frame and have delayed the presentation of this report.

1. ENGINEER AND WORKSHOP.

REVENUE ACCOUNT.

Staff.

(a) *Engineer.*			
Salary at Rs. 1,250 per month	Rs. 15,000		
House Rent at 10 per cent of salary	,, 1,500		
Study Tour of Crop Protection Stations	,, 1,500		
Dearness Allowance	,, 5,481		
Passages (2½ @ Rs. 1,065)	Rs. 2,663	Rs.	26,144
(b) *Plant Protection Officer.*			
Possibly Mr. F. W. J. Lane on hired service from Plant Protection Ltd. for six months including passages		Rs.	13,333
(c) *Other Staff.*			
Fitter, Turner and Welder @ Rs. 100 per mensem each	Rs. 3,600		
Dearness Allowance (994/- ×3)	,, 2,982	,,	6,582

CAPITAL ACCOUNT.

Workshop	Rs. 8,000		
Equipment and Fittings :—			
Lathe with attachments	,, 5,000		
Vertical Drill	,, 1,500		
Grinder	,, 900		
Welding Plant	,, 1,000		
Machine and Hand Tools	,, 2,500		
Bench and Vices	,, 600	Rs. 19,500	
Quarters for minor staff (3)		,, 17,500	,, 37,000
			Rs. 83,059
		Total, Say	Rs. 83,000

2. FIELD EXPERIMENTS.

(a) *Running Costs.*

The primary purpose of these experiments will be to test the *effectiveness* of large scale protection measures.

The experiments will be laid out on a statistical plan and the actual cost of spraying will be secondary. The Engineer will be responsible for development work superimposed on this experiment and designed to reduce the cost of operation to a minimum.

One experiment will be carried out in the South West Monsoon period to examine the possibility of restoring the pre-Blister Blight distribution of labour and crop.

Another experiment will be carried out in the North East Monsoon with the object of supplementing the present system of pruning into dry weather, thus lengthening the period available for pruning. At the present moment pruning is concentrated into a very short period which makes labour distribution exceedingly difficult and costly.

COST OF EACH EXPERIMENT.

200 ACRE SPRAYING EXPERIMENT.

(Based on needs of an *average* estate).

ESTIMATED COST OF LABOUR.

On the assumption that protection is necessary for approximately three months from pruning, this means that a total of some 12 weekly sprayings will be required over the whole 200 acres. To accomplish this a daily labour force made up as follows is considered the minimum possible :—

(1) 6 Spraying gangs of 8 labourers each. Total 48 labourers.

(2) 6 Supervisors, one to each spray gang.

(3) 1 Conductor in general charge of operations.

Completion of the above programme will entail a total of 72 working days per man. On this basis, therefore, labour costs for this experiment are estimated as follows :—

(1) Labourers.		
3,456 days at Rs. 1.90	Rs.	6,566.00
(2) Supervisors.		
342 days at Rs. 2.25	,,	972.00
(3) Conductor.		
3 months at Rs. 150 per mensem	,,	450.00
	Rs.	7,988.40
Total cost of both experiments, say,	Rs.	16,000

(b) *Capital Costs.*

200 ACRE SPRAYING EXPERIMENT.

ESTIMATED CAPITAL COST OF EXTRA EQUIPMENT.

40 Pneumatic Knapsack Sprayers @ Rs. 120 each	Rs.	4,800
2 Four Oak Central Charge pumps @ Rs. 540 each	,,	1,080
2 Gardner Charge Pumps @ Rs. 600 each	,,	1,200
1 40 Gallon tank	,,	100
	Rs.	7,180
Provision for manufacture of new spray booms, nozzles, etc. say 33⅓% of above figure	Rs.	2,393.33
	,,	9,573.33
Total say	Rs.	10,000.00

3. SUSPENSE ACCOUNT

The Board of the Tea Research Institute authorised immediate expenditure from July 1949 on the assumption that it could be recovered later, when special funds are available. At the present moment this suspense account stands at Rs. 14,049.72,

Say ... Rs. 14,000

The activities outlined above will require, therefore, approximately Rs. 123,000 leaving a balance from the estimated average of approximately Rs. 27,000, which is barely sufficient if experiments are carried out with, say, Orchard spraying systems (involving piped supplies of spray fluids), or with power driven "mist blowers."

It may prove possible to induce makers to loan equipment for trial but as most of it has to be modified, makers may be reluct-

ant to allow us to alter loaned machines. I, therefore, suggest that an average of Rs. 150,000 per annum should be made available for four years and that allowance should be made for a higher average expenditure (up to Rs. 200,000) in the first year.

1st year	...	Rs 200,000
2nd „	...	„ 150,000
3rd „	...	„ 125,000
4th „	...	„ 125,000
Average per annum		Rs. 150,000

CONCLUSION.

Dr. T. Swarbrick in addressing the Uva Planters' Association said that 50 per cent of the cost of production of apples in England was accounted for by crop protection items, such as spraying and winter washing. He stressed the point that compared to other crops tea had been fortunate but that Blister Blight is here to stay. Dr. Swarbrick concluded by saying "You will have to learn to live with Blister Blight."

The Tea Research Institute has stressed the same view but not in such apt words. We have, apart from the proposals outlined above, other field experiments designed to modify our agriculture to suit our changed circumstances.

The funds we seek are small compared to the total value of the industry and even to possible loss incurred during the past year. Apart from experiments we must intensify propaganda through lectures and cinematograph shows, to help the planter to re-orientate his ideas and to adapt his management to altered circumstances. We have already been able to borrow four films from Messrs. Plant Protection Ltd. and Pest Control Ltd. shewing the difficulties which have to be faced by growers of other crops. Some part of this special grant for Blister Blight control work could, with great advantage, be spent on the purchase of a cinematograph apparatus and in obtaining suitable films from firms such as Messrs. Plant Protection Ltd., Pest Control Ltd. and the Shell Company. The Ministry of Agriculture in England and the United States Department of Agriculture also have lending libraries of Agricultural films.

Finally, I must acknowledge the assistance rendered by Mr. G. B. Portsmouth, Plant Physiologist; Mr. C. A. Loos, Acting Pathologist; and Mr. F. W. J. Lane, our adviser from Plant Protection Ltd., as well as the Clerical Staff of the Institute. in compiling this report.

(Sgd.) J. LAMB,

Acting Director,
Tea Research Institute of Ceylon.

Tea Research Institute of Ceylon,
St. Coombs,
Talawakelle.
27th November, 1949.

The Tea Research Institute of Ceylon.

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Acting Secretary, J. Lamb, M.Sc., St. Coombs, Talawakelle.

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